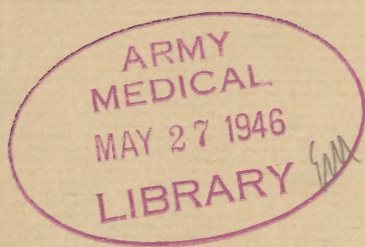


T-13  
11 Mar. 1946

INDEXED

# FOOT DIMENSIONS OF SOLDIERS

Proj. T-13



**ARMORED MEDICAL RESEARCH LABORATORY  
FORT KNOX, KENTUCKY**





# **FOOT DIMENSIONS OF SOLDIERS**

PROJECT NO. T-13 - SURVEY OF  
FOOT MEASUREMENTS OF  
PROPER FIT OF ARMY SHOES  
(THIRD PARTIAL REPORT) ✓

**ARMORED MEDICAL RESEARCH LABORATORY**  
**FORT KNOX, KENTUCKY**

PROJECT NO. T-13  
S.G.O. NO. 611

11 MARCH 1946





# ARMORED MEDICAL RESEARCH LABORATORY

Fort Knox, Kentucky

SPMEA 727.3  
AMRL Project No. T-13  
SGO Project No. 611

11 March 1946

1. PROJECT: No. T-13 - Survey of Foot Measurements and the Proper Fit of Army Shoes. Partial Report No. 3 - Foot Dimensions of Soldiers.
  - a. Authority: 1st Indorsement SPMDO 421.3-ASF-SGO, Washington, D. C., dated 24 September 1945.
  - b. Purpose: To provide information regarding the dimensions of soldiers' feet.

2. DISCUSSION: Foot casualties in the army are numerous both in temperate and in cold climates. Probably because foot dimensions have not heretofore been available, the dimensions of present shoes correspond poorly with those of feet. It is possible that this factor, combined with the use of relatively unyielding materials, may play a large role in the causation of foot casualties. This observation is contingent upon a definition of the fitting requirements of army footgear. Except for length and breadth these have not been defined.

3. CONCLUSIONS:

- a. The feet of a large number of white and Negro troops have been measured. Data are presented for 27 foot dimensions for every subject.
- b. The measurements observed may readily be applied to the alteration of the flare characteristics, toe curve, toe and ball height, and heel curve of present lasts.
- c. More exhaustive examination of the data will be necessary to derive a completely appropriate, new single last pattern for all men. This may not prove possible since it is evident from this report that consistent or orderly schemes of dimensional interrelationships applicable to all, or even to a majority of men, probably do not exist.
- d. Many of the Negro measurements tend to be larger than those of the white troops, while a few tend to be smaller.
- e. Differences exist between the right and left feet of men. There is no consistent pattern of differences however. Over a large population, the differences between the two feet cancel out.

4. RECOMMENDATIONS:

- a. That present army lasts be altered to conform to the measurements observed in this study for the majority of the population. The dimensions for which such alterations appear feasible at present are: degree of flare, toe shape, toe, ball, and outside ball height, and posterior heel contour.



b. That collaborative studies be continued by interested agencies toward a better understanding of army footgear requirements. Undefined as yet are precise fitting standards, the effects of misfitting, and size intervals.

c. That exploration of the present data be continued in the hope of identifying whatever patterns of inter-dimensional relationships may exist.

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## APPENDIX 1

### SUMMARY AND DISCUSSION OF RESULTS

#### DATA APPLICABLE TO SHOE DESIGN

Most shoe dimensions increase directly with increases in size. Some of the dimensions, however, do not and these are therefore susceptible to change without alteration in the general scheme of present shoe manufacture. Such dimensions are the ones such as toe and heel shapes, and toe, ball, and outside ball height, which, it is believed, need only be sufficiently large to accommodate the larger members of the population comfortably to be acceptable to all wearers. The data in appendix 4, for these dimensions, may be applied directly to the modification of lasts to achieve greater conformity with foot characteristics.

The flare of shoes has been found to conform to the shape characteristics of but few feet. As noted in the analysis of the data, the great majority of feet are characterized by some degree of "outflare". Although the selection of one average shape for the revision of present lasts is not ideal since many individuals whose foot shape is not average will still be unsatisfactorily provided for, it will nevertheless constitute an improvement.

#### THE GENERAL REVISION OF SHOE DESIGN BASED ON FOOT MEASUREMENTS

From the point of view of army shoe design, the most important observations in this study have been the wide diversity of foot measurements and the lack of pattern in their interrelationships. Thus, a given foot length may be associated with a great range of ball lengths, a given foot width with a great range of ball girths and heel widths, and either may have high, low or intermediate arch heights, a wide variety of flare characteristics, and a wide variety of measurements of all other dimensions. This scatter of measurements makes every foot an individual type, in the sense that a type is described as possessing a standard set of proportional measurements, for all dimensions.

Were one to select the model measurement for each of the foot dimensions studied for the establishment of a set of dimensional specifications for shoe manufacture, there would remain a large percentage of the population whose foot measurements were either substantially smaller or larger than the ones selected for a given size of shoe. Shoes made as described would not conform to the feet of such individuals. To estimate the number of such unsatisfactorily accommodated individuals would involve a very elaborate set of mathematical computations. Such could be performed, but are useless unless there were first established a set of standards to express with what precision a shoe should fit to the foot.

The first problem is, therefore, to determine how closely a shoe should conform to any and all points on the foot. Is  $1/8$  in. the proper tolerance at the heel rim? Should the inside girth of the vamp of the shoe be smaller or larger than the girth of the metatarsal heads and by how much? It is obvious that precise answers to these questions are not now available. Perhaps they are of little importance, since shoes are worn with at least fair satisfaction by many men. Moreover, it has been found that grossly and deliberately



misfitted shoes produce no symptoms when worn on long, mid-summer marches by seasoned troops<sup>(1)</sup>. On the other hand, it is entirely possible that ill-fitting shoes may be contributory to injury in the cold; this generally conceded though difficult to prove.

To indicate one possible solution to the problem of designing shoes to provide for the widely scattered measurements encountered in this study, a separate report has been prepared<sup>(2)</sup>. This report takes into account the fact that the probability of injury from ill-fitting, in the cold and elsewhere, is a function of the resilience of the material confining the foot, and concludes that a yielding fabric is less likely to be injurious than heavy, less yielding leather.

#### DIFFERENCES IN MEASUREMENTS BETWEEN WHITE AND NEGRO SUBJECTS

In certain of the dimensions the Negro measurements were found to be larger than those of the white subjects, while in others they were of similar order of magnitude or smaller. The following list summarizes these tendencies, the details of which are shown in the ensuing section:

NEGRO  $\approx$  WHITE

Foot Length  
Ball Length  
5th Toe Length  
Outside Ball Length  
Toe Height  
Foot Breadth  
Ball Girth  
Breadth of Instep  
Proportion of Instep in Contact  
    With Ground  
Instep Girth  
Heel Breadth  
Indentation of Achilles Tendon  
    Above Calcaneus  
Diagonal Ankle Girth  
Ankle Length

NEGRO  $\approx$  WHITE

Toe Length  
Breadth of 3 Forward Toes  
Height of Great Toe Tip  
Outflare  
Ball Height  
Outside Ball Height  
Plantar Arch Height  
Dorsal Arch Height  
Lower Leg Girth

In general it appears that all length, breadth and girth measurements, and the dorsal toe elevation of the Negroes tend to be larger than those of the white subjects. On the other hand, toe length and breadth, all height measurements of the ball and arch, and the girth of the lower leg appear to be smaller among the Negroes. This pattern of differences is surprisingly consistent. With regard to the findings of greater breadth and girth measurements, it is likely that the clinical observation of the greater frequency of

(1) Armored Medical Research Laboratory Project No. T13 - 1st Partial Report Study of Factors Bearing on the Establishment of Size Tariffs, on Size Designations, and on Shoe Fitting - 4 Dec 1945.

(2) Armored Medical Research Laboratory Project No. T13 - 4th Partial Report Analysis of Characteristics of Footgear for Army Field Use - In preparation.



fleshiness of the foot among the Negroes (9.98%) is at least in part responsible. The arch and instep measurements of the Negroes are of interest in that the arch heights are less while the instep breadth and girth are greater than they are among the white subjects. The greater anterior indentation of the heel among Negroes doubtless is related to the smaller lower leg girth in this group. It is not known whether the larger toe height observed among the Negro subjects is a natural characteristic or is attributable to the greater frequency of toe elevation and deformity in this group.

#### DIFFERENCES BETWEEN RIGHT AND LEFT FOOT MEASUREMENTS

It was standard practice throughout the study to measure only the right foot, and all data presented relate to that extremity. For five selected dimensions, however, both the right and left feet were measured, and the differences between the two feet tabulated. The results were as follows:

##### DIFFERENCES IN MEASUREMENT BETWEEN RIGHT AND LEFT FOOT

###### FOOT LENGTH

	No. Subjects	Mean Difference mm.
Identical	1004	0
Right Larger Than Left	1909	2.60
Left Larger Than Right	2658	2.88

###### BALL LENGTH

	No. Subjects	Mean Difference mm.
Identical	621	0
Right Larger Than Left	1685	3.23
Left Larger Than Right	3264	4.19

##### BALL WIDTH (DIAGONAL)

	No. Subjects	Mean Difference mm.
Identical	1907	0
Right Larger Than Left	1176	2.13
Left Larger Than Right	2485	2.36

# BALL GIRTH

	No. Subjects	Mean Difference mm.
Identical	768	0
Right Larger Than Left	2481	3.32
Left Larger Than Right	2322	3.20

# DORSAL ARCH HEIGHT

	No. Subjects	Mean Difference mm.
Identical	1321	0
Right Larger Than Left	2787	3.22
Left Larger Than Right	1463	2.82

The extent to which these differences are real, or are only reflections of the lack of precision with which any set of duplicate measurements are possible, is reviewed in the text. For each of the dimensions above, a figure is presented in the ensuing section comparing the duplicability of the measurements on one foot with the comparison of the measurements on the two feet.



## Purpose, Organization, and Techniques

## A. Introduction:

Foot casualties among troops in both temperate and cold environments are numerous and probably to a large degree unnecessary. Although there is no convincing proof, it has been assumed that many of these casualties are either induced or aggravated by the footgear issued by the Army and result from what has been loosely termed "misfitting". Preliminary studies by the Laboratory (1) revealed that the size of shoes issued to inductees at Fort Knox were, in a great many instances, not in conformity with the dimensions of the men's feet. During the conduct of this study, it became apparent that existing standards of shoe fitting were by no means precise and perhaps were not appropriate to Army requirements, however acceptable they may have been for civilian usage. Current shoe fitting standards apply only to toe and ball lengths and to snugness at the vamp. They call for a standard excess of shoe length over the toe length, approximate precision of fit for the ball length, and a glovelike approximation to the foot for the vamp area. The implication is that with the accomplishment of these and one or two other requirements, the remainder of the shoe automatically bears the proper relationship to the foot at all other points. X-ray studies and marching tests (1,2) made it clear, however, that the fitting of shoes involved considerably more than the assignment of a stated size to a particular man. The approximation of the shoe to the foot at the heel, at the arch, in the region of the small toe, under the lacing, and at many other sites, are all involved in fitting, although the precision with which this is accomplished is very difficult to ascertain and the nature and frequency of the casualties produced by the failure to achieve proper foot and shoe relationship are not completely understood.

Experience suggests that the establishment of dimensional tolerances between the foot and shoe depends on the activity of the wearer, the climate to which he is exposed, the materials of which the shoe is made, and the type and rigidity of its construction. It is apparent that investigations of these features of shoe design require a base line of factual information. The present study was instituted, therefore, to examine the dimensions of men's feet in as complete detail as possible for that purpose.

This report does not answer the questions pertaining to the proper space between foot and shoe, nor are dynamic factors involved in the wearing of shoes discussed. Nevertheless there is provided information concerning the static foot with regard to fundamental shape characteristics, with regard to dimensional interrelationship, and with regard to the range of measurements

- 
- (1) The Design and Fit of Army Shoes, Report T-10, Armored Medical Research Laboratory, Fort Knox, Kentucky, June 12, 1945.
  - (2) Survey of Foot Measurements and the Proper Fit of Army Shoes, Report T-13, 1st Partial Report, Armored Medical Research Laboratory, Fort Knox, Kentucky, December 4, 1945.

# DATA SHEET

NAME \_\_\_\_\_ LAST \_\_\_\_\_ FIRST \_\_\_\_\_ INITIAL \_\_\_\_\_ ASN \_\_\_\_\_

	NUMBER	AGE YRS.	HEIGHT CM.	WEIGHT KILO.	PLACE ENLISTED	CLINICAL EVALUATION
COLUMN	1-2-3-4	5-6	7-8	9-10	11	12
MEASUREMENT						
<b>DIAGRAM</b>					<b>MEASURE- MENT</b>	<b>IDM CARD COLUMN</b>
M	HEIGHT OF GREAT TOE TIP					13-14
O	TOE HEIGHT					15-16
	IDENTIFICATION OF MOST ELEVATED TOE					17
P	BALL HEIGHT					18-19
R	PLANTAR ARCH HEIGHT					20-21
RY	DORSAL ARCH HEIGHT				RIGHT	22-23
RY	HEIGHT-SAME				LEFT	NEGRO: INTERORBITAL DISTANCE
	DIFFERENCE					+ - 24-25
Q	OUTSIDE BALL HEIGHT					NASAL BREADTH
T	ANKLE LENGTH					LIP THICKNESS
	POSTERIOR HEEL CONTOUR					26-27
						28-29
M	BALL GIRTH				RIGHT	30
M	GIRTH-SAME				LEFT	FACIAL BREADTH
	DIFFERENCE					31-32
						UMBILICAL GIRTH
S	ANKLE GIRTH					+ - 33-34
V	LOWER LEG GIRTH					35-36
AC	FOOT LENGTH				RIGHT	37-38
AC	LENGTH-SAME				LEFT	39-40
	DIFFERENCE					+ - 41-42
A	BALL LENGTH				RIGHT	43-44
A	LENGTH-SAME				LEFT	
	DIFFERENCE					+ - 45-46
C	TOE LENGTH					47-48
B	5TH TOE LENGTH					49-50
U	OUTSIDE BALL LENGTH					51-52
KL	BREADTH OF 3 FORWARD TOES					53-54
J	FOOT BREADTH (DIAGONAL)				RIGHT	55-56
J	BREADTH-SAME				LEFT	
	DIFFERENCE					+ - 63-64
	ANGLE-LINE I TO LINE J					57-58
	CONTOUR AND ORIENTATION OF TOES (BY TEMPLATE)					59-60
DE	BALL BREADTH ON HORIZONTAL				RIGHT	61-62
D	WIDTH-CENTER LINE TO MEDIAL BORDER				RIGHT	65-66
	FLARE (RATIO D/DE)					67-68
GM	BREADTH OF INSTEP					69-70
G	PROPORTION OF SOLE IN CONTACT WITH GROUND					71
	LATERAL FOOT CONTOUR (BY TEMPLATE)					72
F	HEEL BREADTH					73-74
X	INSTEP GIRTH					75-76
AC <sup>3</sup>	FOOT LENGTH (STICK)					77-78
I	OUTSIDE BALL LENGTH DIAGONAL					79-80

Figure 1



encountered among the population. With such information, the specifications of present shoes may be appraised and appropriate modifications made. These may then be subjected to field study in a systematic manner.

A plan was developed to secure as many foot measurements as seemed necessary for the definition of the variety of foot sizes and shapes, on a sufficient number of subjects to be representative of the young, male population of the Army. The selection of the appropriate measurements was made on the basis of the experience accumulated by the Laboratory, and modified in accordance with suggestions offered by the Quartermaster representatives, shoe and last manufacturers, an orthopedist, and an anthropologist. Special effort was made to select and define the dimensions to be measured in such a way that the position of each in space could be described. Accordingly, in general, all length and breadth measurements are referred to a set of rectilinear coordinates by orienting the foot prior to measuring, and, wherever necessary, measurements are referred to definable landmarks on the foot surface or at a standard distance from some constant reference point. Accordingly, the measurements are not in every instance those in current use by the shoe trade.

#### B. Methods:

Technicians were selected from among troops stationed at Fort Knox, and were trained in the measuring procedures. Approximately 50 enlisted men served as measures, photographers and scribes. Medical Officers performed the clinical examinations.

The measurements were recorded by scribes on a data sheet (Fig.1). Figure 2 and 3 illustrate the measurements taken and the coding system used.

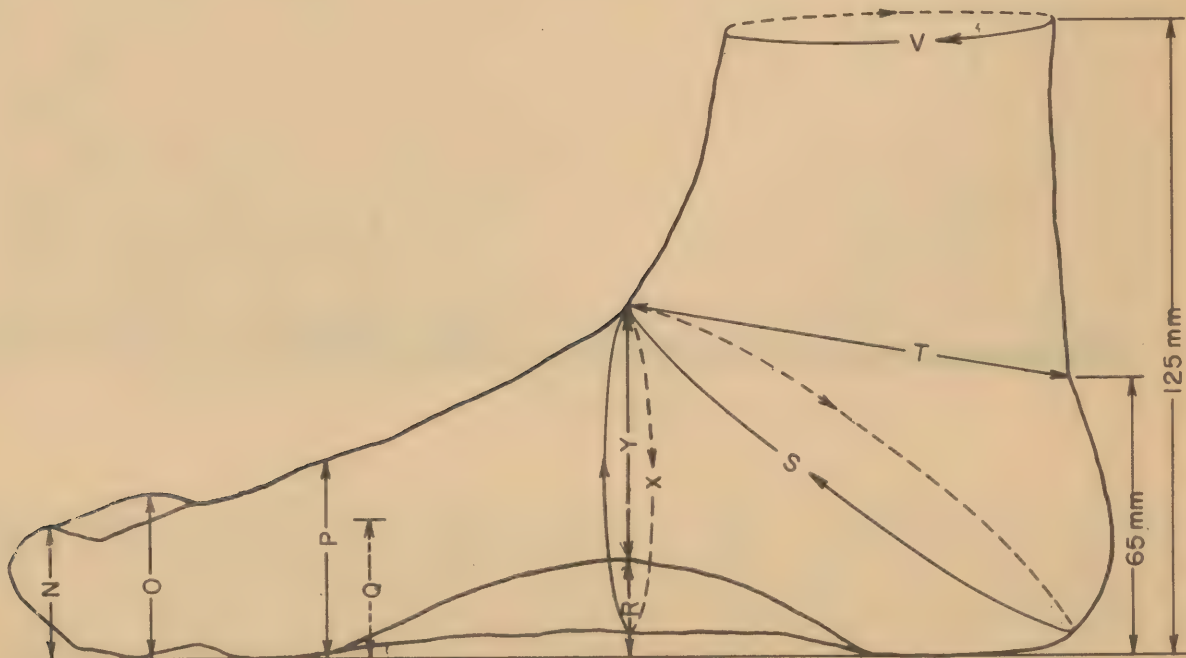


Figure 2

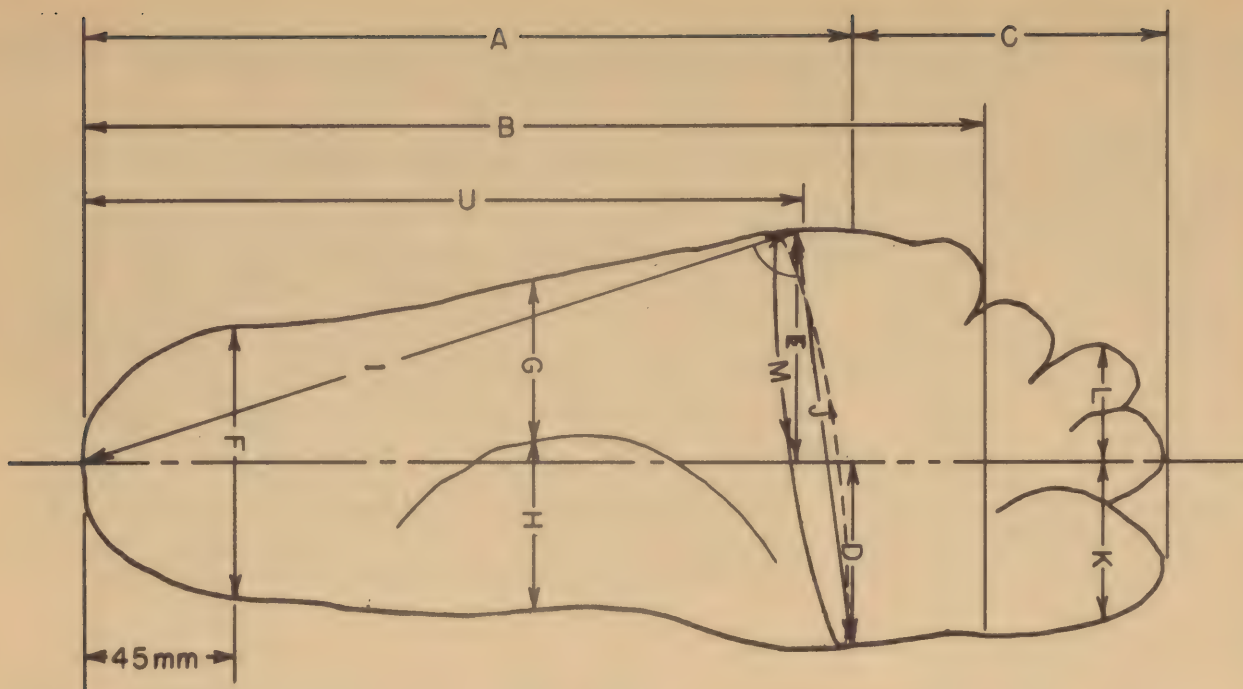


Figure 3

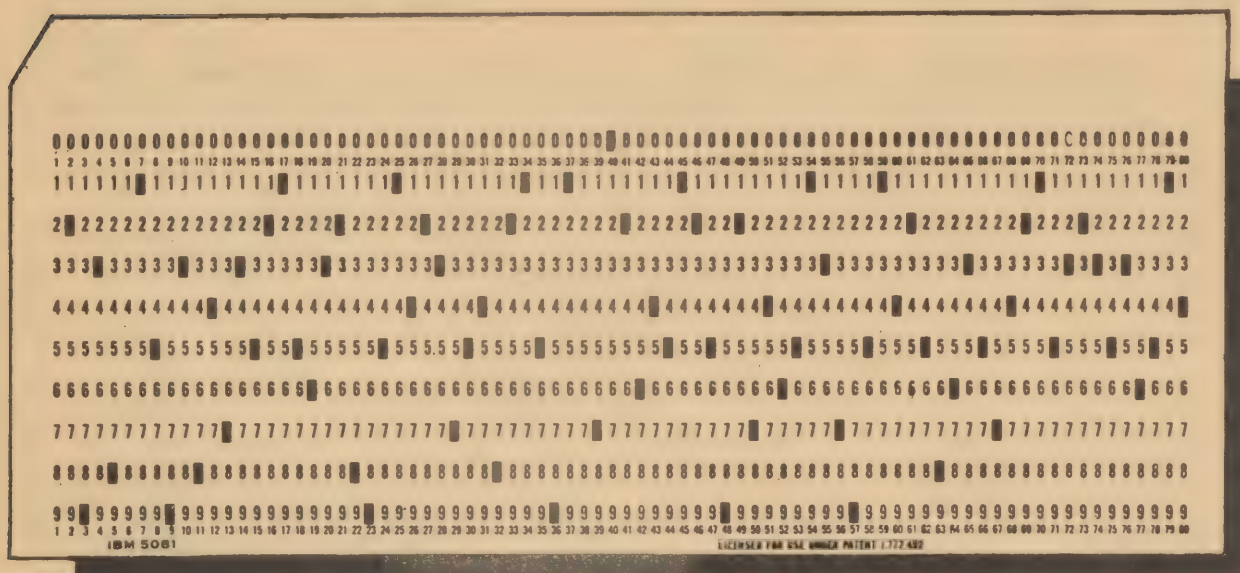


Figure 4

Following the completion of the measurements the data were transposed to IBM cards (Fig. 4), the column numbers for which may be noted on the data sheet. The information presented in this report was abstracted from these cards. Special measurements were made on the Negro troops to establish the similarity or dis-similarity of their physical characteristics with respect to the Negro population generally; a detailed description of these is given in Appendix 3.



The subjects were processed on a schedule which permitted the examination of approximately 200 men each half day. The troops were brought by truck to the hall and disrobed, retaining only their shorts. Personal information and measurement data were obtained from each man in turn, which the subjects proceeded from one technician to the next in an orderly fashion. Somewhat less than 20 minutes was required for each subject to traverse the line, the subjects being separated by 1 to 2 minute intervals. All measurements were made with subjects standing relaxed but erect on tables, care being taken that the body weight was equally distributed between the two feet. Figure 5 presents a panoramic view of the layout and processing procedure, the subjects starting on the left, proceeding to the camera tables in the right background, and thence to the measuring tables in the center foreground.



Figure 5  
Panoramic view

#### C. Data Collected:

The data collected were designed to provide essential information concerning the subject and those shape and dimensional characteristics of his feet regarded pertinent to the design of footgear. Information was therefore obtained from each subject regarding:

1. Age, height, weight, and place enlisted.
2. Anatomical description of the foot.
3. Dimensional and shape characteristics for:
  - a. Length.
  - b. The toe region.
  - c. The region of the metatarsal heads.
  - d. The instep region.
  - e. The heel and ankle region.
4. Differences between the right and left feet for five representative dimensions.

The following is a detailed description of each of the dimensional characteristics studied:

#### LENGTH

Designation	Where Measured
1. Foot length	Length from heel to longest toe tip along rectilinear ordinates.
2. Ball length	Length from heel to soft tissue prominence medial to 1st metatarso-phalangeal joint.
3. 5th toe length	Length from heel to anterior 5th toe tip, along rectilinear ordinates.
4. Outside ball length	Length from heel to soft tissue prominence lateral to 5th metatarso-phalangeal joint, along rectilinear ordinates.
5. Outside ball length (diagonal)	Same, measured on diagonal.

#### TOE REGION

6. Toe length	Length from soft tissue prominence medial to 1st metatarso-phalangeal joint to longest toe tip, along rectilinear ordinates.
7. Breadth of three forward toes	The maximal breadth from the medial border of the great toe to the lateral border of the 3rd toe.
8. Toe height	Height from the ground to the most prominent dorsal toe surface. In each case the most prominent dorsal toe surface was identified.
9. Height of great toe tip	Height from the ground to the dorsal surface of the tip of the great toe.
10. Anterior curvature and orientation of toes	Curvilinear characteristics of anterior toe margins, with orientation of their general conformation to the line connecting the 1st and 5th metatarso-phalangeal prominences.



# METATARSAL REGION

Designation	Where Measured
11. Foot breadth (diagonal)	Breadth of diagonal between the prominence of the 1st and 5th metatarso-phalangeal joints.
12. Foot breadth (horizontal)	Breadth along a rectilinear abscissa between the longitudinal planes defined by the prominences of the 1st and 5th metatarso-phalangeal joints, and parallel to the longitudinal axis.
13. Foot flare	Medial or lateral deviation of the metatarsal region of the foot in relation to the heel. Expressed as a ratio of the portion of the foot breadth located medial to the longitudinal plantar axis to the total foot breadth.
14. Ball girth	Girth just posterior to the maximal prominences of the 1st and 5th metatarso-phalangeal joints.
15. Ball height	Height from the ground to the dorsal foot surface in the region of the 1st metatarso-phalangeal joint.
16. Outside ball height	Height from the ground to the dorsal foot surface in the region of the 5th metatarso-phalangeal joint.
17. Angular orientation of metatarsal heads	Angular relationship of the line connecting the 1st and 5th metatarso-phalangeal prominences to a line connecting the 5th metatarso-phalangeal prominence with the center of the posterior heel rim curve.
18. Lateral foot contour	Contour of the lateral curved margin of the 5th and 4th toes in relation to the relatively straight lateral margin of the foot posterior to the 5th metatarso-phalangeal joint prominence.
19. Plantar arch height	Height from the ground to the superior margin of the plantar curvature of the arch on the medial aspect of the foot in the plant of the junction of the foot and leg.

## METATARSAL REGION

Designation	Where Measured
20. Dorsal arch height	Height from the ground to the dorsal foot surface at the junction of the foot and leg.
21. Breadth of instep	Breadth of the sole in the plane of the junction of the foot and leg. In each case an estimate was made of that proportion of the total breadth which was in contact with the ground.
22. Instep girth	Girth in the plane of the junction of the foot and leg.

## HEEL AND ANKLE REGION

23. Heel breadth	Breadth of heel 45 mm. forward of the posterior heel margin.
24. Posterior heel contour	Contour of the posterior aspect to the heel and lower leg in the mid-sagittal plane, to a height of 72 mm. (2 4/5 in.) above the ground.
25. Diagonal ankle girth	Girth around posterior-inferior aspect of the heel and the dorsal junction of the foot and leg.
26. Ankle length	Length from posterior aspect of leg, 65 mm. (2 9/16 in.) above the ground, to the junction of the foot and leg.
27. Lower leg girth	Girth of the leg, 125 mm (4 15/16 in.) above the ground.

### D. Technical Procedures:

1. Preliminary data. This was secured by interrogation. Each subject was assigned a number, and his age at last birthday and place of enlistment were recorded (Fig. 6).

2. Height and Weight. Height was measured to the nearest centimeter (Fig. 7). The subject stood with his back to a wall to which a scale was attached, and a square was used for reading off the measurement. Greater precision was not sought because the degree of erectness can introduce an error of 1 cm. on repeat measurement. A beam balance was used for weighing; this was recorded to the nearest kilogram. The lack of control of preceding activity, meals, or time of excretory functions, any of which can change the weight by 1 kg., made this degree of precision the minimum feasible.





Figure 6. Personal Data



Figure 7. Height and Weight

3. Clinical Evaluation. The subjects' feet were examined by Medical Officers. Inspection alone was used, no history being elicited. The sole aim of the clinical examination was to secure a record of those feet possessing peculiarities of shape and structure which might influence the dimensions of the part involved. In this way it was hoped to arrive at an evaluation of the frequency and nature of aberrations of foot shape likely to be unsuitably accommodated by a shoe of standard design. The dimensional data are correlated with the clinical evaluations in the ensuing appendices.

4. Reference Markings. In order to standardize the foot regions at which the various measurements were to be taken, two technicians were occupied exclusively with indicating, by means of ink lines, several points on the feet as follows (Fig.8):

a. The centers of the fleshy protrusion on the medial surface at the ball, and on the lateral surface in the region of the 5th metatarso-



Figure 8. Marking Feet

phalangeal joint, as determined by inspection from directly above the foot. The marks were extended to be visible on both the dorsal and plantar aspects of the foot. These points were chosen in preference to the bony prominences of the metatarso-phalangeal articulations both because the soft tissue is important in shoe fitting and because of greater ease of identification. Bony contours of these joints are not always precisely identified by palpation even by the most expert.

b. The highest points on the two previously described prominences. These were indicated by lines crossing the preceding ones at their highest points.

c. A horizontal line in the lowest crease of the skin produced over the extensor hallucis longus tendon when the subject flexed his knees and ankles while standing with his weight equally balanced on both feet. This line was taken to be the dorsal junction of the foot and leg.

d. In the plane of the above mark a vertical line was then drawn on the medial aspect of the foot, crossing a line indicating the superior margin of the curvature of the hollow of the instep.

e. Lines were finally placed on the posterior aspect of the heel and lower leg, 65 and 125 mm. above the ground respectively.

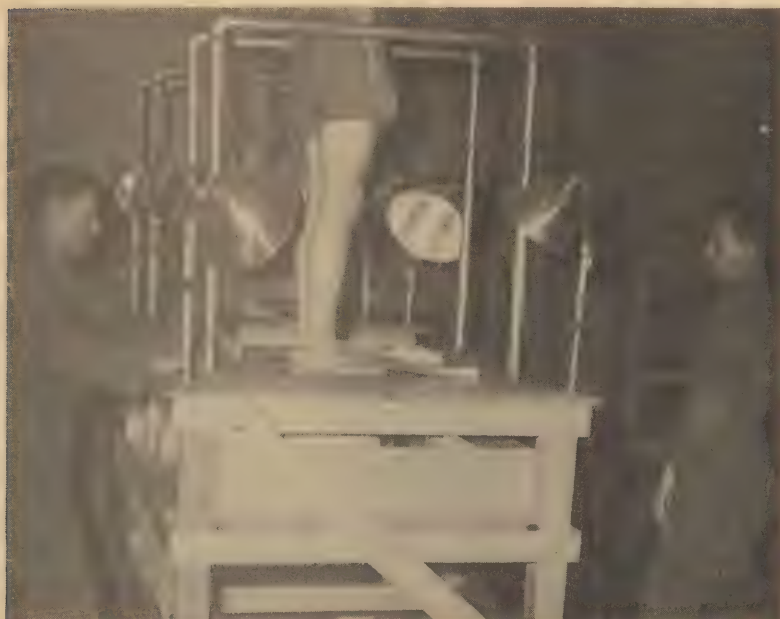


Figure 9. Photographic Platform

5. Photographic Technique. For the photograph of the soles of his feet, the subject mounted to the top of a six foot platform (Fig. 9) where an attendant placed his feet on a specially hardened plate of glass. The glass was ruled with rectilinear coordinates 2 mm. apart. Above and in the recesses of the platform incandescent and fluorescent lighting was placed for illumination. The camera was securely attached to the same frame near the floor and focused on the glass plate so that the illumination and focus remained constant.

Certain inadequacies became apparent in the photographing equipment and in its use, as the study progressed. The focal distance of the camera was inconvenient, and it would have been desirable to use orthochromatic rather than panchromatic film in order to more sharply outline the weight bearing areas of the sole. The expansion and shrinkage of the enlarging paper was a problem not anticipated, but a technique was developed for handling this which minimized the errors attributed to this cause.



Most important was an unavoidable error introduced by the photographic technique. The image on the film was shorter than the true foot length by an amount proportional both to the distance of the anterior and posterior foot margins from the center of focus and to the elevation of these margins above the surface of the glass plate. The toe elevations ranged from 15 to 25 mm. above the glass plate surface, while the elevations at the heel were somewhat less. For simplicity, a mean elevation of 15 mm. was assumed. This required an additive correction to the photographed foot lengths for all subjects, of 3 mm. The calculation is illustrated in Fig. 10. In addition to this a further correction of 2 mm. was necessary due to an error in the printing of the coordinates on the glass. Thus, the standard correction totaled 5mm.: 3 mm. for focus and elevation, and 2 mm. for the error in the coordinates. Both these faults, however, were so located as to be significant only in total foot length determinations.

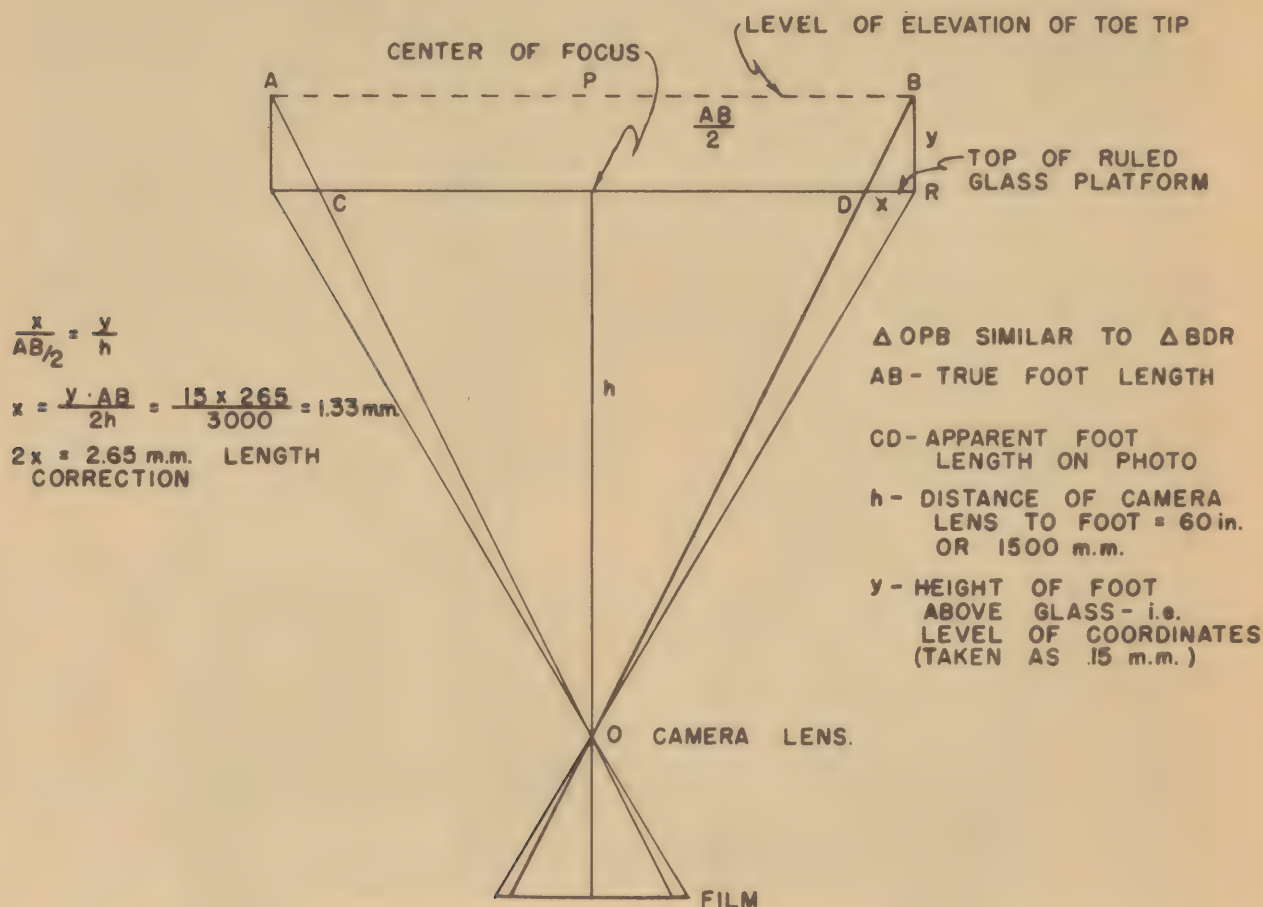
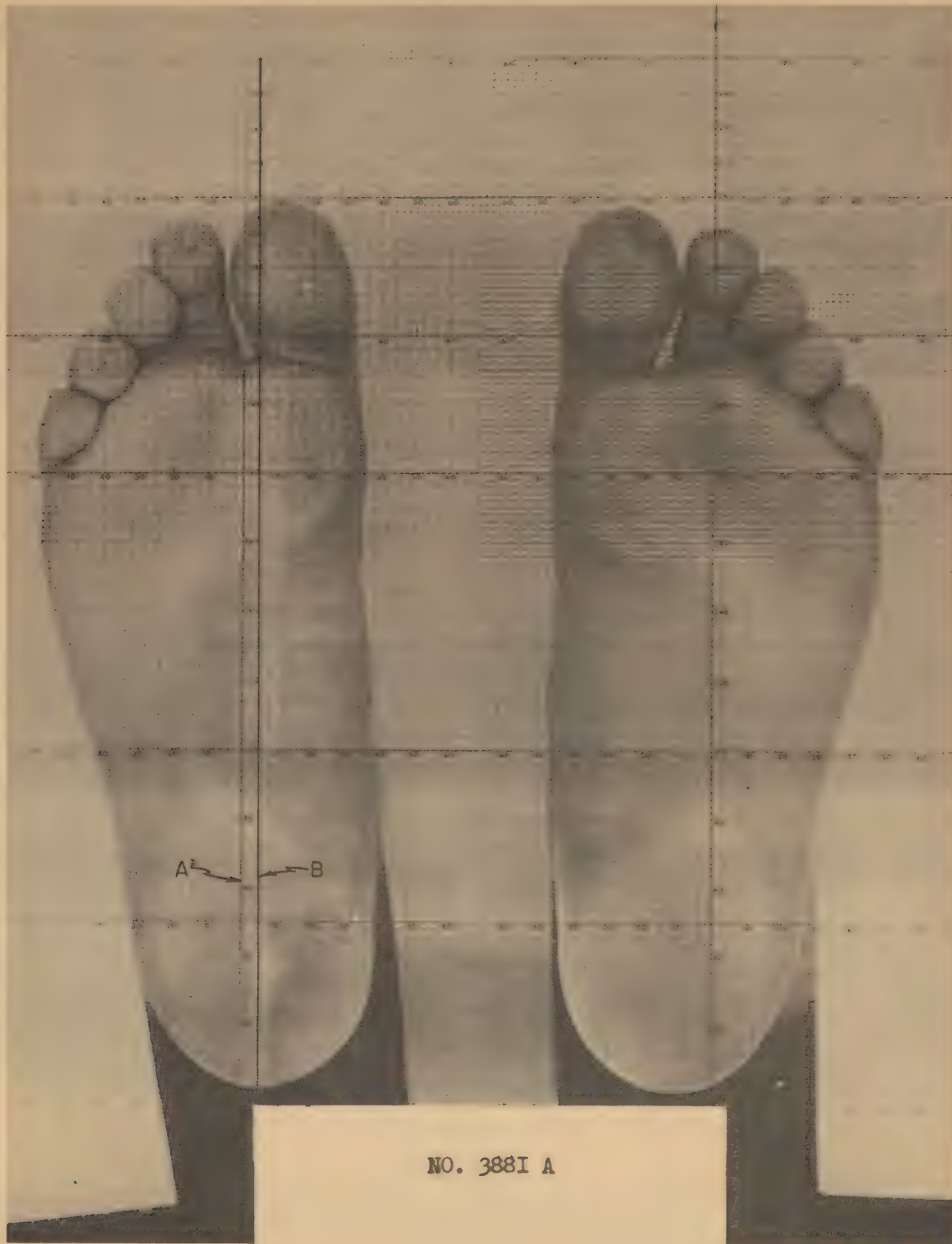


Figure 10

Note: The camera, film, and enlarging paper were supplied by the Signal Corps. The camera was a Folmar-Graflex unit, known as identification equipment PH-385, stock No. 8A1885 (equipped) to handle 100 ft. rolls of 35 mm. film, single frame exposure. The film was of the panchromatic type, stock No. 8D-1, speed group 50. The enlarging paper was Kodabromide F-2, single weight, white-smooth-glossy, 8 x 10. The enlarger was an Omega, manufactured by Simon Bros. Inc.



NO. 388I A

Figure 11



The exposed film was developed by the Signal Corps Photo Laboratory, Army War College; enlarging and printing were accomplished as a part of the experimental procedure at Fort Knox.

6. Measurements Derived from the Photograph. The Photograph image of the sole was enlarged to 8 x 10 size, a sample of which is shown as Fig. 11. On it may be seen the coordinates described above. From this print the measurements pertaining to the plantar surface were derived (Fig. 3).

The instruments used in taking the plantar measurements are shown in Fig. 12. They consisted of:

a. Plastic Scale. This scale was calibrated to the scale of the photograph, 0 to 320 mm., with 2 mm. divisions; it was used for all linear plantar measurements (Fig. 12B).

b. Template for Describing the Forward Toe Margin. In the course of analyzing the photographs certain measurement expedients were adopted to describe the curvilinear characteristics of the feet. For this purpose templates were made of transparent plastic so that a coded system of shapes rather than a dimensional system might be used. The templates for classifying the forward toe margin contours were made up from curves drawn from an exploratory series of photographs. These were divided into four basic shapes (Fig. 12A), and were then further sub-divided by adding five base lines separated from each other by an angle of  $5^{\circ}$ . There was no attempt to identify size with these curves; only the contour and orientation of the toes to the metatarsal region of the foot were determined. The templates were placed on the photograph so as to superimpose their medial borders onto the medial great toe border while the base line was in contact with the point marking the first metatarso-phalangeal prominence. That template was selected which in its basic shape most closely approximated the outline of the entire anterior toe margin. The code number was read off on that base line which fell on the mark denoting the 5th metatarso-phalangeal prominence (Fig. 12A and 13A).

c. Template for Lateral Foot Curvature. The lateral foot border curvature at the 5th metatarso-phalangeal prominence was described with a template that consisted of a series of curves all oriented to a single reference line.

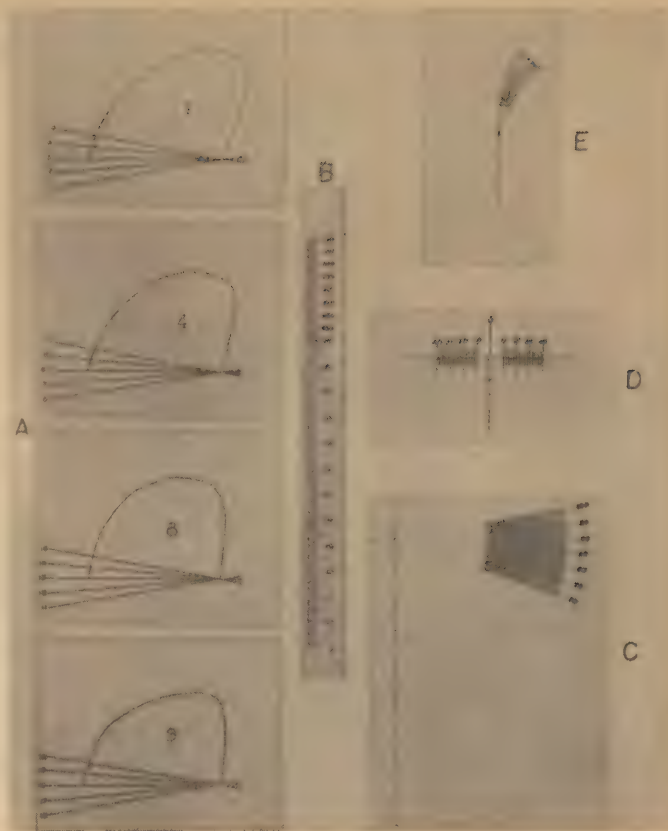


Figure 12. Plastic Scales for Plantar Measurements.

This line was superimposed on the lateral border of the foot so that the mark at the beginning of the curve was also superimposed on the 5th metatarso-phalangeal prominence mark on the photograph. The curvature was then ascertained as that which most closely approximated the lateral 5th and/or 4th toe margins (Fig. 12E and 13B).

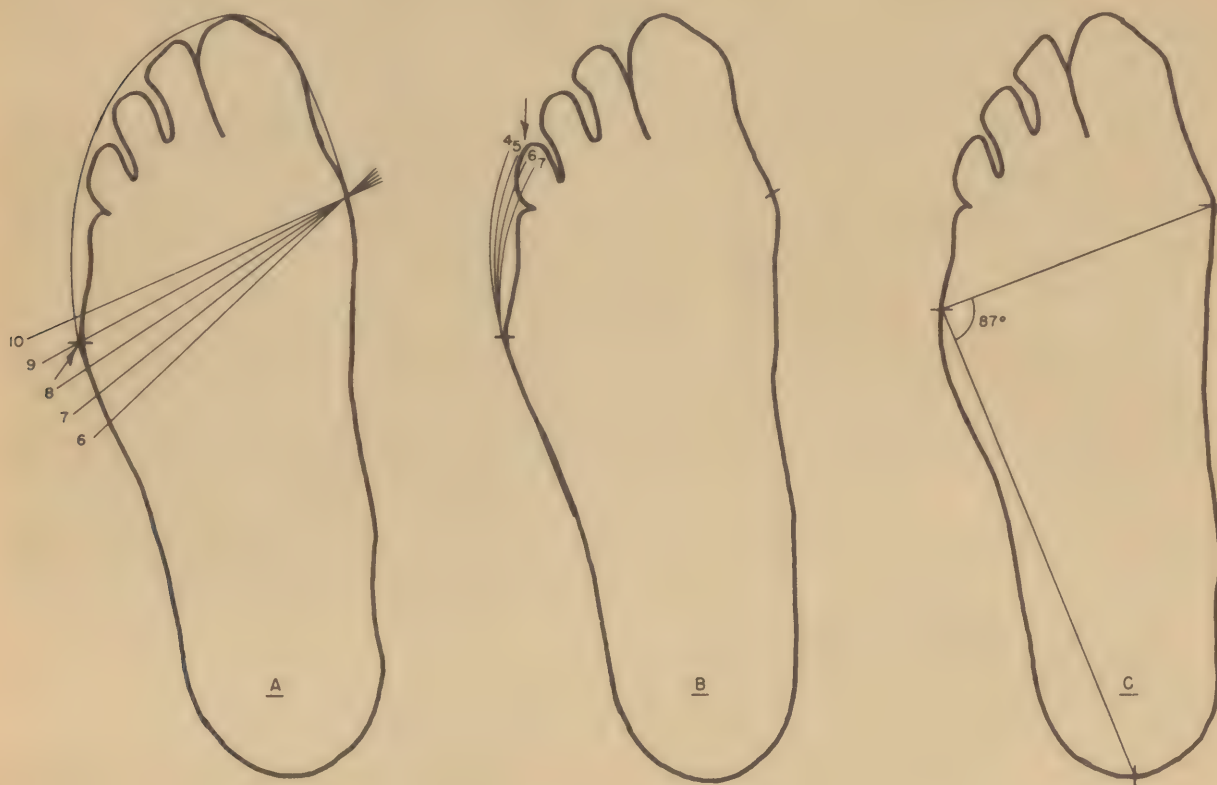


Figure 13  
Methods of Template Fitting

d. Protractor for Heel Line-Metatarsal Angle. In order to orient the line joining the 1st and 5th metatarso-phalangeal prominences to the posterior part of the foot, the angle formed by the conjunction of this line and another line connecting the 5th metatarso-phalangeal prominence with the center of the posterior heel rim was measured with a special protractor, at the 5th metatarso-phalangeal prominence (Fig. 12C and 13C).

e. Scale for Locating the Longitudinal Plantar Axis. It was the original intent that a stationary clamp (Fig. 14 and 15), adjustable to the heel width by means of a reciprocating skate screw and hinged to the photographic platform, would automatically place the subject's heel on the centering line of the coordinates. It was intended that the subject's heel would be fixed in place by an attendant, prior to the photography, in such a way as to bring the subject's foot onto the grid glass to automatically define the foot axis in terms of a line bisecting the heel (Fig. 11-line A). It was found, however, upon comparing check photographs that the clamp did not place the foot in the same relation to the centering line with constancy.



It, therefore, became necessary to draw a new axis onto the completed print in 68% of the cases. This was accomplished in the following manner: with the aid of the scale, two breadth bisecting points, 10 mm. and 50 mm. forward of the posterior rim of the heel were determined; a line was then drawn connecting these two points and extended to the forepart of the foot. This was done systematically except for the rare case in which it was impossible because of the rounded contour of the medial aspect of the heel. Both the constancy attained with this "drawn-in axis" and the "clamp axis" are shown in the ensuing Appendices (Fig. 12D and 11-line B).



Figure 14  
Heel Clamp



Figure 15  
Placing Heel in Clamp

7. Direct Measurements. The instruments used in measuring the dorsum and circumferential aspects of the subjects' feet are shown in Fig. 16. They consisted of:

a. Meter Sticks. These sticks had bases attached perpendicularly for height measurements. The caliper arms shown are standard meter sticksjaws from which the lock screws were removed to permit the insertion of a segment of spring steel to maintain the caliper jaws at all times normal to the stocks (Fig. 16A).

b. Measuring Tapes. These were metrically calibrated linen tapes supplied



Figure 16  
Instruments for Dorsal Measurements

by Lufkin, and cut to convenient lengths. All girth measurements were taken with them (Fig. 16B).

c. Calipers. These were made from meter sticks and were used to measure the dimension from the foot-leg junction to the rear of the heel (Fig. 16C).

d. Standard Foot Measuring Sticks. These were sticks as used in the shoe trade altered by calibration in millimeters (Fig. 16D).

e. Gauges. These were made from meter sticks; they were used to mark the posterior aspect of the foot and ankle at 65 mm. and 125 mm. above the ground (Fig. 16F).

f. Templates for Describing the Posterior Heel Curvature. Since the shape of the heel in the mid-sagittal plane posteriorly is an irregular curve, the use of graded templates of varying degree of curvature was adopted for their description. These were made of sheet aluminum and given code numbers. They were made by first preparing cardboard templates fashioned to fit each heel in a test group; similar shapes were then combined to select the least number of final shapes required. Twelve such standard templates and one special template were sufficient to classify all but 20 cases among the white subjects. The same 12 standard templates were used for the Negro subjects, but it was found that 8 additional templates were required to accommodate 266 of the 274 individuals possessing heel shape variations too extreme to be classified by the original 12 templates (Fig. 16E).

#### E. Control of the Accuracy of the Data:

The methods employed to assure the accuracy of the measurements consisted of several different approaches to the problem. The various tapes and measuring instruments were checked against standard meter sticks and metal tapes and these checks were repeated at various intervals with special attention to detect any stretching of the linen tapes with usage. As the linen tapes became badly soiled, they were replaced with new ones to make accurate readings easier.

In order to detect any errors that might develop in measuring the subjects, a special team of measurers was employed doing only check measurements after all the original measurements had been completed. These check measurements were made as frequently as possible and were varied from subject to subject so that all girth and height measurements received as nearly equal treatment as possible. Whenever a difference was detected of sufficient magnitude to indicate the likelihood of an error, the subject was remeasured for that particular measurement and any necessary change made on the recording sheet. Usually 2 mm. for linear measurements and 5 mm. for girth measurements were taken as the dividing points between probable errors and allowable differences.

As a further check to detect any bias that might arise over a period of time, random samples of a hundred sheets were taken every few days and the various measurements were tabulated and the means calculated. A comparison between these groups of a hundred was then made to assure that there were no differences of a magnitude that would exceed those expected from pure chance.



Measurements taken from the photographs were done twice, each time by a different individual, and any difference of more than two millimeters was checked again and changed if necessary. In the case of the fitting of templates, determining the angle measurements, and estimating bearing surfaces, there were no check measurements. For these, conscientious workers were selected and kept at the particular task so that there would be uniform judgments insofar as possible. All arithmetic calculations were checked by duplicate operations.

To check the precision of the photographic technique in measuring foot length, about 2/3 of the subjects were also measured with calipers (standard shoe stick, calibrated in millimeters). Fig. 17 indicates that for all the subjects so checked, the caliper measurement of foot length tends to average approximately 1 mm. shorter than the length measured from the photograph, perhaps due to soft tissue compression.

As a further check upon the accuracy of all the measurements and as an indication of how closely measurements could be duplicated by the same group of measurers, several groups of subjects were put through the entire procedure twice. All marks were carefully removed from these subjects' feet, and each was given a new recording sheet and sent through the procedure as though he were a new subject. A total of 199 individuals were treated in this manner; and the measurements were taken and processed in the usual way. The two record sheets on each of these subjects were then paired and the differences recorded, using a (+) sign to indicate that the measurement was larger the first time, and a (-) sign to indicate the converse.

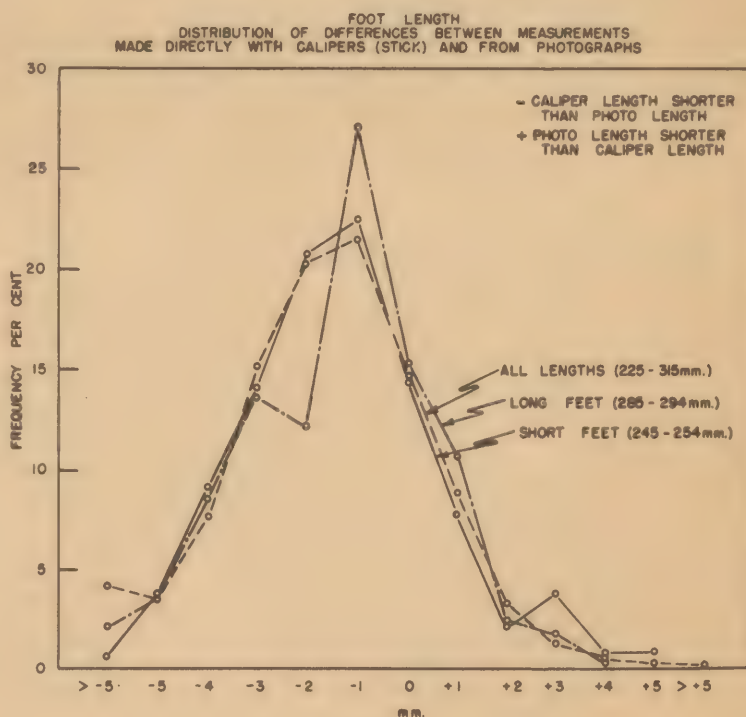


Figure 17

Distributions of the magnitude and frequency of differences between the two sets of duplicate measurements are presented in the appropriate appendices in association with the data to which they refer.

2

2



## APPENDIX 3

### THE SUBJECTS

#### A. SOURCE OF SUBJECTS

6278 white subjects and 1281 Negro subjects were examined in all. The white subjects were either in basic training or were members of the enlisted cadre at the Armored Replacement Training Center at Fort Knox. For the most part those in basic training were in their third month of Army service. The Negro subjects were Air Corps personnel, principally ground enlisted personnel from Godman Field, adjacent to Fort Knox, who had been in the service for from 1 to 4 years.

All of these subjects were not included in the final study. Analyses made on 5575 white and 1200 Negro subjects only. The subjects not a part of the final study were excluded for the causes shown in Table 1, and the nature of the gross physical defects responsible for the exclusion of 20 of the white subjects is given in Table 2.

TABLE 1

Causes For Exclusion of Subjects		
Cause	White	Negro
Practice Runs	474	0
Photo Failures	207	76
Gross Physical Defects	20	0
Other	2	5
	703	81

TABLE 2

Clinical Findings in Those Subjects Excluded For Gross Physical Defects	
Clinical Defect	Number
Edema Due to Recent Trauma	10
Amputation of Toes	4
Lipomata	4
Exostoses	1
Heel Blister of Excessive Size	1
	20

#### B. REPRESENTATIVENESS OF THE SAMPLE

GENERAL - The practical utility of these data for the Army depends on the extent to which the subjects are representative of the Army population as a whole. Two questions become apparent immediately. Does the presence of a large number of white inductees 18 years of age affect the distribution of the measurements? And, did the location of the study at Fort Knox, in Kentucky, afford a proper representation of men from all the regions of the country? There is presented below information from several sources for evaluating these and similar questions.

AGE - At the time this study was undertaken the Selective Service was inducting a large number of men 18 years of age. Accordingly, approximately 50% of the white subjects were in this age group. However, previously deferred

men were also being inducted at this time, and about 25% of the white subjects were, therefore, in the age group 26-29. This was not true of the Negroes who had been in the service longer, and who, therefore, had a more even representation of men of all ages. Fig. 18 gives the distribution of the present subjects by age compared with the Army population as of September 30, 1945(1). Inspection of Table 3, which is indicative of the correlation between age and length and breadth of the foot for white subjects, reveals that the distribution of these basic foot dimensions cannot be greatly influenced by age; apparently any size of foot may be possessed by a man of any age. This does not imply, of course, that 18 year old men have attained their full growth, although it is unlikely that foot dimensions are altered to a substantial degree with the further progression of anatomical maturity.

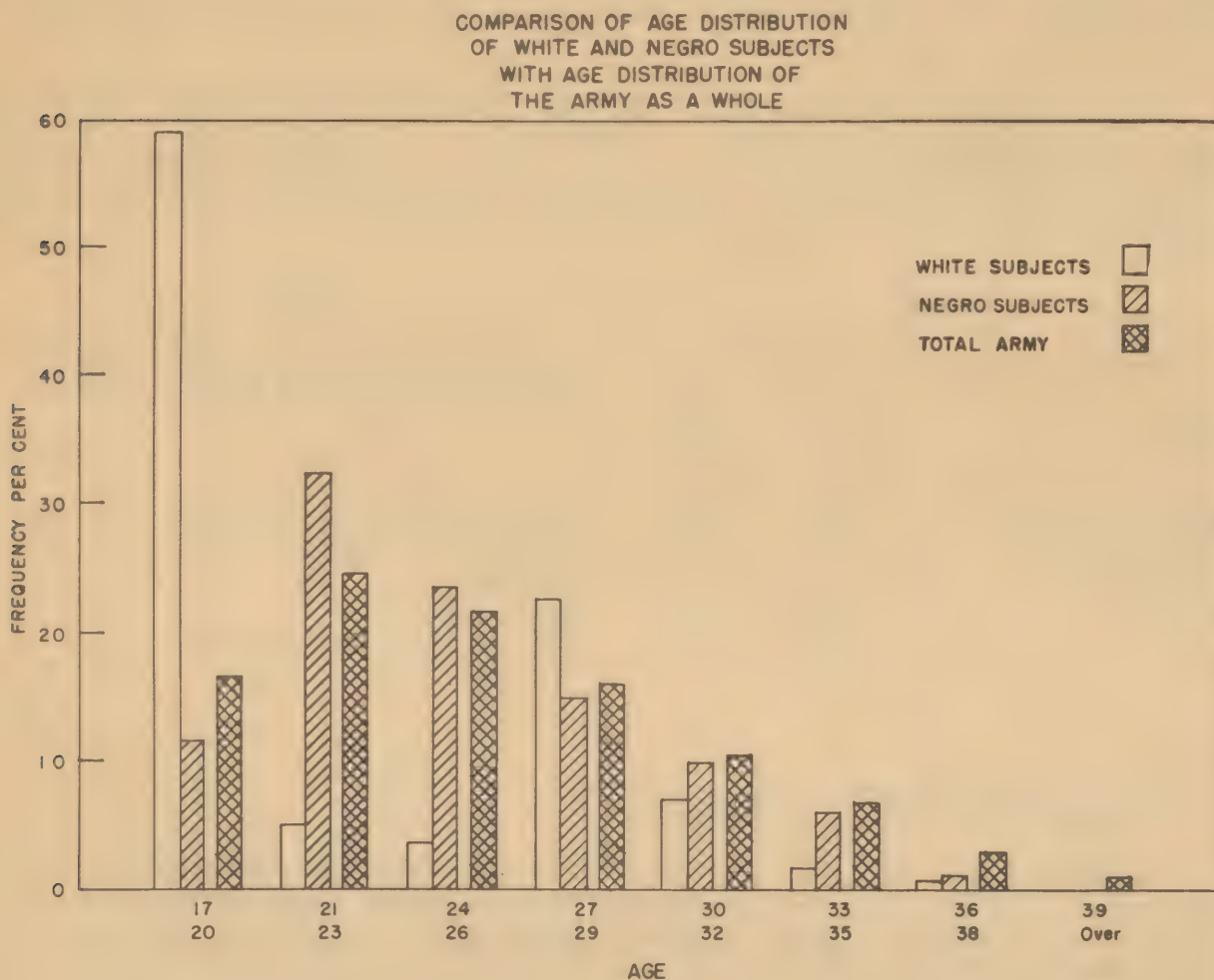


Figure 18

(1) Information supplied by the SGO for six million men in the Army as of September 30, 1945.



TABLE 3  
CORRELATION BETWEEN AGE AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		AGE						TOTAL
		17-20	21-23	24-26	27-29	30-32	33-35	
mm.	in.							
84-89	3 5/16 - 3 8/16.....							
90-95	3 9/16 - 3 12/16.....				2			2
96-101	3 13/16 - 4.....	1			1	1		3
102-107	4 - 4 3/16.....	1						1
108-113	4 4/16 - 4 7/16.....							
114-119	4 8/16 - 4 11/16.....							
120-125	4 12/16 - 4 15/16.....							
TOTAL.....		2			3	1		6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16 - 3 8/16.....	4	1	1				6
90-95	3 9/16 - 3 12/16.....	18	2		5	1	1	27
96-101	3 13/16 - 4.....	23	3	4	11	4		45
102-107	4 - 4 3/16.....	3	1	1	1	3		9
108-113	4 4/16 - 4 7/16.....							
114-119	4 8/16 - 4 11/16.....							
120-125	4 12/16 - 4 15/16.....							
TOTAL.....		48	7	6	17	8	1	87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16 - 3 8/16.....	1				1		2
90-95	3 9/16 - 3 12/16.....	53	6	1	15	5	2	84
96-101	3 13/16 - 4.....	182	13	12	87	24	5	326
102-107	4 - 4 3/16.....	76	1	5	32	9	3	128
108-113	4 4/16 - 4 7/16.....	6	1		4			11
114-119	4 8/16 - 4 11/16.....	2	1					3
120-125	4 12/16 - 4 15/16.....							
TOTAL.....		320	22	18	138	39	10	554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16 - 3 8/16.....				1			1
90-95	3 9/16 - 3 12/16.....	44	2	3	10	6	1	66
96-101	3 13/16 - 4.....	373	34	24	162	51	12	664
102-107	4 - 4 3/16.....	301	24	28	143	46	15	560
108-113	4 4/16 - 4 7/16.....	45	7	6	17	6	1	83
114-119	4 8/16 - 4 11/16.....	3			2			5
120-125	4 12/16 - 4 15/16.....							
TOTAL.....		766	67	61	335	109	29	1379

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16 - 3 8/16.....							
90-95	3 9/16 - 3 12/16.....	13	4	1	4	2		24
96-101	3 13/16 - 4.....	302	18	15	94	30	11	474
102-107	4 - 4 3/16.....	605	51	28	232	67	16	1004
108-113	4 4/16 - 4 7/16.....	163	19	6	68	23	5	286
114-119	4 8/16 - 4 11/16.....	12	3		3	3	1	22
120-125	4 12/16 - 4 15/16.....							
TOTAL.....		1095	95	50	401	125	33	1810

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		AGE						TOTAL
		17-20	21-23	24-26	27-29	30-32	33-35	36-38
mm.	in.							
84-89	3 5/16 - 3 8/16.....							
90-95	3 9/16 - 3 12/16.....	3	2		3			8
96-101	3 13/16 - 4.....	115	9	7	32	15		178
102-107	4 - 4 3/16.....	382	23	18	142	45	7	618
108-113	4 4/16 - 4 7/16.....	194	26	21	80	18	6	347
114-119	4 8/16 - 4 11/16.....	23	3	3	13	3	1	46
120-125	4 12/16 - 4 15/16.....	2		1	1			4
TOTAL.....		719	63	50	271	81	14	1201

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

mm.	in.							
84-89	3 5/16 - 3 8/16.....							
90-95	3 9/16 - 3 12/16.....				1	1		2
96-101	3 13/16 - 4.....	14	3		2	1		21
102-107	4 - 4 3/16.....	103	6	6	27	11	3	157
108-113	4 4/16 - 4 7/16.....	115	7	8	39	9	1	180
114-119	4 8/16 - 4 11/16.....	36	4	3	9	4	2	58
120-125	4 12/16 - 4 15/16.....	5			1			6
TOTAL.....		273	20	17	79	26	6	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

mm.	in.							
84-89	3 5/16 - 3 8/16.....							
90-95	3 9/16 - 3 12/16.....							
96-101	3 13/16 - 4.....				1			1
102-107	4 - 4 3/16.....	12	1	2	3	1		19
108-113	4 4/16 - 4 7/16.....	25	5		4	3		38
114-119	4 8/16 - 4 11/16.....	15	3	1	3	2		24
120-125	4 12/16 - 4 15/16.....	4		1	1			6
TOTAL.....		56	9	4	12	6	1	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

mm.	in.							
84-89	3 5/16 - 3 8/16.....							
90-95	3 9/16 - 3 12/16.....							
96-101	3 13/16 - 4.....							
102-107	4 - 4 3/16.....	1			2			3
108-113	4 4/16 - 4 7/16.....	1			1			2
114-119	4 8/16 - 4 11/16.....	7						7
120-125	4 12/16 - 4 15/16.....	1						1
TOTAL.....		10			3			13

HEIGHT & WEIGHT - The height and weight distribution of the subjects of this study correspond much more closely to those of the Army as a whole, as shown in Figs., 19, 20, 21 & 22. The data for the height and weight distribution for the army was obtained from a 1943 publication of the Surgeon General's Office (2). Since the correspondence of height and weight is good, it is only a matter of academic interest, from the point of view of this study, whether these attributes influence foot dimensions. It is worthy of note, however, that the shorter men tend to possess shorter and narrower feet, while taller men tend toward the other extreme (Table 4). This same tendency is apparent in the relationship of weight to length and breadth of feet (Table 5), as would be expected, since there is a natural correlation between height and weight.

(2) "Height & Weight Data for Men Inducted into the Army and for Rejected Men", Report No. 1, BM, ASF-SGO, Medical Statistics Division.



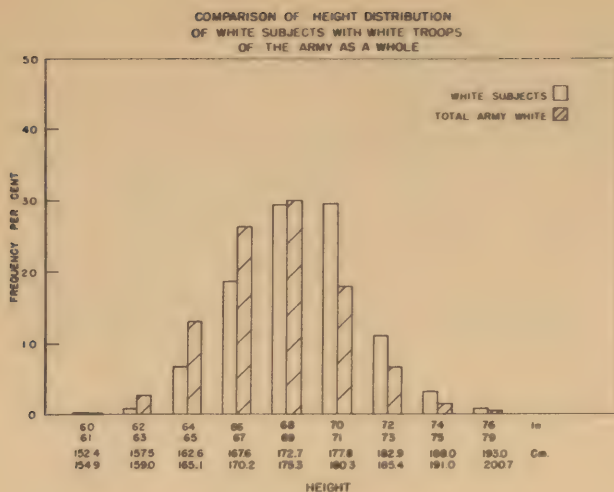


Figure 19

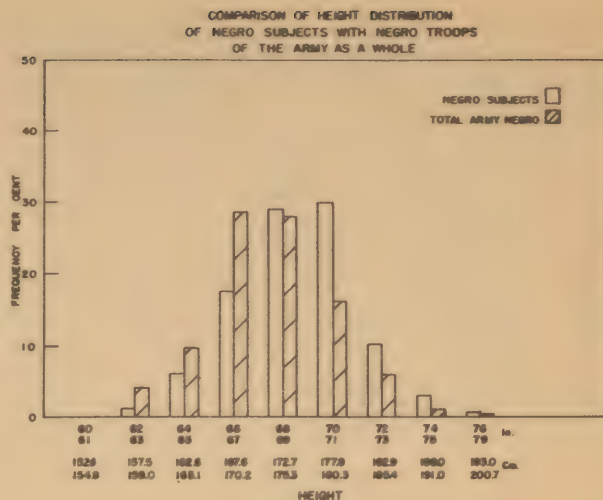


Figure 20

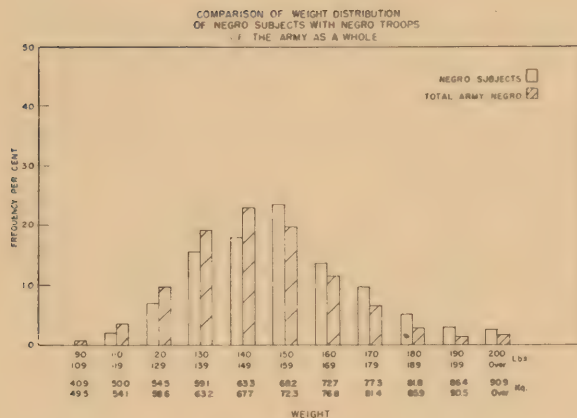


Figure 21

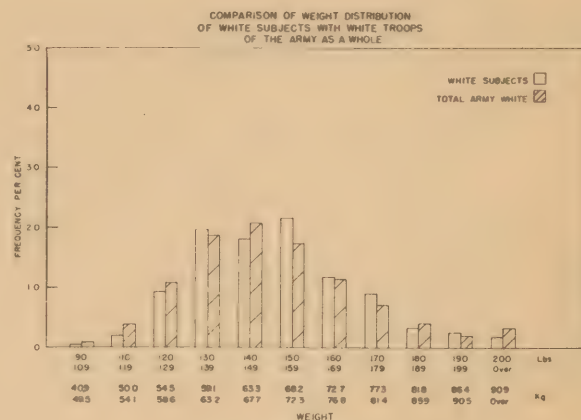


Figure 22

PLACE ENLISTED - Information was obtained from each subject regarding the State from which he was inducted into the Army. No attempt was made to determine whether this represented his home or whether it was the state in which he was reared. It probably may be presumed, however, that the place of enlistment and the childhood home were identical for a majority of the subjects. From this information the individual was classified as emanating from one of nine geographical regions in accordance with the plan used by the Public Health Service in reporting communicable disease (3). This plan was selected because it divides the country into a convenient and standard arrangement of climatic regions. The regional code numbers assigned were, therefore, as follows:

- |                        |                        |                        |
|------------------------|------------------------|------------------------|
| 1 - New England        | 4 - West North Central | 7 - West South Central |
| 2 - Middle Atlantic    | 5 - South Atlantic     | 8 - Mountain           |
| 3 - East North Central | 6 - East South Central | 9 - Pacific            |

(3) Public Health Reports, U.S. Gov't Printing Office.

TABLE 4  
CORRELATION BETWEEN HEIGHT OF SUBJECT AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		HEIGHT (Cm.)									TOTAL
		155- Less	156- 160	161- 165	166- 170	171- 175	176- 180	181- 185	186- 190	191- 195	
mm.	in.										
84-89	3 5/16 - 3 8/16..	.....									
90-95	3 9/16 - 3 12/16..	.....	1	1							2
96-101	3 13/16 - 4.....	1		2							3
102-107	4 - 4 3/16.....			1							1
108-113	4 4/16 - 4 7/16..										
114-119	4 8/16 - 4 11/16..										
120-125	4 12/16 - 4 15/16..										
TOTAL.....		1	1	4							6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16 - 3 8/16..	.....	2	4								6
90-95	3 9/16 - 3 12/16..	2	4	12	6	2	1					27
96-101	3 13/16 - 4.....	4	4	26	10	1						45
102-107	4 - 4 3/16.....	2		7								9
108-113	4 4/16 - 4 7/16..											
114-119	4 8/16 - 4 11/16..											
120-125	4 12/16 - 4 15/16..											
TOTAL.....		8	10	49	16	3	1					87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16 - 3 8/16..	.....			2							2
90-95	3 9/16 - 3 12/16..	1	11	21	33	15	3					84
96-101	3 13/16 - 4.....		21	124	126	50	5					326
102-107	4 - 4 3/16.....	1	4	42	59	19	3					128
108-113	4 4/16 - 4 7/16..			1	7	1	2					11
114-119	4 8/16 - 4 11/16..			1	2							3
120-125	4 12/16 - 4 15/16..											
TOTAL.....		2	36	189	229	85	13					554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16 - 3 8/16..	.....				1						1
90-95	3 9/16 - 3 12/16..	.....	2	11	23	23	5	2				66
96-101	3 13/16 - 4.....	.....	12	102	264	219	55	12	1			665
102-107	4 - 4 3/16.....	1	3	71	193	203	76	12	1			560
108-113	4 4/16 - 4 7/16..			10	25	39	7	2				83
114-119	4 8/16 - 4 11/16..			1	1	2	1					5
120-125	4 12/16 - 4 15/16..											
TOTAL.....		1	17	195	506	487	144	28	2			1380

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16 - 3 8/16..	.....										
90-95	3 9/16 - 3 12/16..	.....		1	4	7	10	2				24
96-101	3 13/16 - 4.....	.....	1	18	115	200	115	23	3			475
102-107	4 - 4 3/16.....	.....	1	30	187	428	288	64	7			1005
108-113	4 4/16 - 4 7/16..	.....		4	43	115	93	26	5			286
114-119	4 8/16 - 4 11/16..	.....			2	8	8	3	1			22
120-125	4 12/16 - 4 15/16..	.....										
TOTAL.....		.....	2	53	351	758	514	118	16			1812



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		HEIGHT (Cm.)									TOTAL
		155- Less	156- 160	161- 165	166- 170	171- 175	176- 180	181- 185	186- 190	191- 195	
mm.	in.										
84-89	3 5/16 - 3 8/16..										
90-95	3 9/16 - 3 12/16..				1	1	5	1			8
96-101	3 13/16 - 4.....			1	9	44	78	41	5		178
102-107	4 - 4 3/16.....			3	30	167	259	130	28	2	619
108-113	4 4/16 - 4 7/16..				25	81	140	90	10	1	347
114-119	4 8/16 - 4 11/16..				3	10	18	10	3	2	46
120-125	4 12/16 - 4 15/16..							1	2	1	4
TOTAL.....				4	68	303	500	273	48	6	1202

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16 - 3 8/16..											
90-95	3 9/16 - 3 12/16..					1		1				2
96-101	3 13/16 - 4.....				1	4	4	9	2	1		21
102-107	4 - 4 3/16.....				5	15	49	62	21	4	1	157
108-113	4 4/16 - 4 7/16..					20	64	57	36	3		180
114-119	4 8/16 - 4 11/16..					6	13	23	15	1		58
120-125	4 12/16 - 4 15/16..						1	2	3			6
TOTAL.....					6	46	131	154	77	9	1	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16 - 3 8/16..											
90-95	3 9/16 - 3 12/16..											
96-101	3 13/16 - 4.....							1				1
102-107	4 - 4 3/16.....						1	9	5	3	1	19
108-113	4 4/16 - 4 7/16..					1	7	11	17	1	1	38
114-119	4 8/16 - 4 11/16..					1	4	8	9	2		24
120-125	4 12/16 - 4 15/16..						1	4	1			6
TOTAL.....						2	13	33	32	6	2	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16 - 3 8/16..											
90-95	3 9/16 - 3 12/16..											
96-101	3 13/16 - 4.....											
102-107	4 - 4 3/16.....							1	1	1		3
108-113	4 4/16 - 4 7/16..								2			2
114-119	4 8/16 - 4 11/16..							2	1	4		7
120-125	4 12/16 - 4 15/16..								1			1
TOTAL.....								3	5	5		13

It was found that although a preponderance of white subjects was from the East North Central States and a preponderance of the Negro subjects was from the South Atlantic and East South Central States, nevertheless the general distribution corresponded well with the region of origin for the Army as a whole (4); and the proportional representation of subjects from the far western States was in good agreement with that of the total Army population (Fig. 23 & 24). In any case there is no gross evidence that the ranges of foot length and width are influenced by geographic origin (Table 6).

(4) "Selective Service as the Tide of War Turns", 3rd report 1943-1944, U.S. Gov't Printing Office, p 574

TABLE 5  
CORRELATION BETWEEN WEIGHT OF SUBJECT AND  
LENGTH AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		WEIGHT (Kg.)											TOTAL
		51- Less	52- 57	58- 63	64- 69	70- 75	76- 81	82- 87	88- 93	94- 99	100- 105	106 & Over	
mm.	in.												
84-89	3 5/16-3 8/16			1									2
90-95	3 9/16-3 12/16		1	2		1							3
96-101	3 13/16-4			1									1
102-107	4 - 4 3/16												
108-113	4 4/16-4 7/16												
114-119	4 8/16-4 11/16												
120-125	4 12/16-4 15/16												
TOTAL			1	4		1							6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16	4	1		1								6
90-95	3 9/16-3 12/16	2	9	12	4								27
96-101	3 13/16-4	4	17	16	4	3	1						45
102-107	4 - 4 3/16		2	3	2	1	1						9
108-113	4 4/16-4 7/16												
114-119	4 8/16-4 11/16												
120-125	4 12/16-4 15/16												
TOTAL		10	29	31	11	4	2						87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16		1	1									2
90-95	3 9/16-3 12/16	8	40	26	8		2						84
96-101	3 13/16-4	8	70	141	84	21	2						326
102-107	4 - 4 3/16		15	47	34	24	7	1					128
108-113	4 4/16-4 7/16		1	2	4	1	1	2					11
114-119	4 8/16-4 11/16			1	1	1							3
120-125	4 12/16-4 15/16												
TOTAL		16	127	218	131	47	12	3					554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16					1							1
90-95	3 9/16-3 12/16	2	20	33	9	2							66
96-101	3 13/16-4	7	115	244	182	91	22	4					665
102-107	4 - 4 3/16		31	163	170	133	47	9	3				556
108-113	4 4/16-4 7/16		4	13	20	28	6	5	4	2	1		83
114-119	4 8/16-4 11/16				1		2	1		1			5
120-125	4 12/16-4 15/16												
TOTAL		9	170	453	382	255	77	19	7	3	1		1376

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16												
90-95	3 9/16-3 12/16	1	7	8	7			1					24
96-101	3 13/16-4	3	48	167	155	78	19	3	3	2			478
102-107	4 - 4 3/16		29	188	357	258	116	38	14	4			1004
108-113	4 4/16-4 7/16			22	83	85	49	28	9	10			286
114-119	4 8/16-4 11/16		1		5	4	5	2	2	2		1	22
120-125	4 12/16-4 15/16												
TOTAL		4	85	385	607	425	189	72	28	18		1	1814



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		WEIGHT (Kg.)											TOTAL
		51- Less	52- 57	58- 63	64- 69	70- 75	76- 81	82- 87	88- 93	94- 99	100- 105	106- Over	
mm.	in.												
84-89	3 5/16-3 8/16.....												8
90-95	3 9/16-3 12/16.....		2	4	1	1							178
96-101	3 13/16-4.....		8	45	65	39	14	5	2				619
102-107	4 - 4 3/16.....	1	7	84	175	197	90	48	11	4	1	1	347
108-113	4 4/16-4 7/16.....			17	74	104	90	34	21	4	3		46
114-119	4 8/16-4 11/16.....					12	13	12	6	3			4
120-125	4 12/16-4 15/16.....					1	2		1				
TOTAL.....		1	17	150	315	354	209	99	41	11	4	1	1202

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16.....												2
90-95	3 9/16-3 12/16.....				1		1						21
96-101	3 13/16-4.....		1	2	7	8	1	2					157
102-107	4 - 4 3/16.....		1	12	36	55	29	18	4	2			180
108-113	4 4/16-4 7/16.....			6	21	50	58	27	8	7	3		58
114-119	4 8/16-4 11/16.....			1	5	4	16	10	15	3	3	1	6
120-125	4 12/16-4 15/16.....						3	2		1			
TOTAL.....			2	21	70	117	108	59	27	13	6	1	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16.....												
90-95	3 9/16-3 12/16.....												1
96-101	3 13/16-4.....						1						19
102-107	4 - 4 3/16.....				3	8	6	2					38
108-113	4 4/16-4 7/16.....				2	10	13	7	5	1			24
114-119	4 8/16-4 11/16.....				2	5	2	8	3	2	1	1	6
120-125	4 12/16-4 15/16.....						2		3		1		
TOTAL.....					7	23	24	17	11	3	2	1	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16.....												
90-95	3 9/16-3 12/16.....												
96-101	3 13/16-4.....												
102-107	4 - 4 3/16.....				1	1	1						3
108-113	4 4/16-4 7/16.....						1	1					2
114-119	4 8/16-4 11/16.....					2	2	2	1				7
120-125	4 12/16-4 15/16.....								1				1
TOTAL.....					1	3	4	3	2				13

SIZE COMPARISON - The recorded foot lengths of the white subjects studied were converted from millimeters to shoe size groupings in accordance with the manufacturing specifications for Munson Lasts(5). This corresponds very closely to size dimensions derived from the Clark measuring device. These were then compared with the size tariffs for service shoes(6). In doing so, it was necessary to assume that a given size shoe would be issued to a soldier

(5) Lasts, Hinge, Munson, Quartermaster Corps Specifications. BQD No. 71, May 14, 1942.

(6) Size Tariffs, War Dept. Supply Bulletin SB 10-136

TABLE 6  
CORRELATION BETWEEN PLACE OF ENLISTMENT (SEE TEXT) AND  
LENGTH AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		PLACE OF ENLISTMENT ( SEE TEXT )									TOTAL
		1	2	3	4	5	6	7	8	9	
mm.	in.										
84-89	3 5/16 - 3 8/16.....										
90-95	3 9/16 - 3 12/16.....		1	1							2
96-101	3 13/16 - 4.....		2	1							3
102-107	4 - 4 3/16.....		1								1
108-113	4 4/16 - 4 7/16.....										
114-119	4 8/16 - 4 11/16.....										
120-125	4 12/16 - 4 15/16.....										
TOTAL.....			4	2							6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16 - 3 8/16.....	1	2	2	1						6
90-95	3 9/16 - 3 12/16.....	3	9	10	1	1	1	2			27
96-101	3 13/16 - 4.....	3	17	10	2	5		6	2		45
102-107	4 - 4 3/16.....	1	2	3	1	1		1			9
108-113	4 4/16 - 4 7/16.....										
114-119	4 8/16 - 4 11/16.....										
120-125	4 12/16 - 4 15/16.....										
TOTAL.....		8	30	25	5	7	1	9	2		87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16 - 3 8/16.....		1	1							2
90-95	3 9/16 - 3 12/16.....	3	23	25	9	6	2	12	4		84
96-101	3 13/16 - 4.....	25	94	99	17	36	18	23	1	13	326
102-107	4 - 4 3/16.....	8	32	44	6	22	3	7	3		128
108-113	4 4/16 - 4 7/16.....	2	2	3			2	2			11
114-119	4 8/16 - 4 11/16.....		2	1							3
120-125	4 12/16 - 4 15/16.....										
TOTAL.....		38	154	173	32	64	25	44	8	16	554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16 - 3 8/16.....				1						1
90-95	3 9/16 - 3 12/16.....	1	25	24	3	7	3	2	1		66
96-101	3 13/16 - 4.....	31	177	228	40	73	29	55	5	27	665
102-107	4 - 4 3/16.....	31	132	184	40	82	33	38	6	14	560
108-113	4 4/16 - 4 7/16.....	4	21	25	4	13	6	4	1	5	83
114-119	4 8/16 - 4 11/16.....		1	3	1						5
120-125	4 12/16 - 4 15/16.....										
TOTAL.....		67	356	464	89	175	71	99	13	46	1380

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16 - 3 8/16.....										
90-95	3 9/16 - 3 12/16.....	4	10	4		4	1		1		24
96-101	3 13/16 - 4.....	32	108	158	35	59	31	30	1	21	475
102-107	4 - 4 3/16.....	65	193	348	94	125	50	93	11	26	1005
108-113	4 4/16 - 4 7/16.....	12	49	95	28	37	24	32	4	5	286
114-119	4 8/16 - 4 11/16.....		2	9	2	3	2	4			22
120-125	4 12/16 - 4 15/16.....										
TOTAL.....		113	362	614	159	228	108	159	17	52	1812



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		PLACE OF ENLISTMENT ( SEE TEXT )									TOTAL
		1	2	3	4	5	6	7	8	9	
mm.	in.										
84-89	3 5/16 - 3 8/16.....										
90-95	3 9/16 - 3 12/16.....	2	1	1	2	2					8
96-101	3 13/16 - 4.....	13	39	68	15	18	4	14	2	5	178
102-107	4 - 4 3/16.....	35	125	225	53	70	29	63	2	17	619
108-113	4 4/16 - 4 7/16.....	17	64	124	25	50	27	32	4	3	346
114-119	4 8/16 - 4 11/16.....	4	4	14	4	10	2	7		1	46
120-125	4 12/16 - 4 15/16.....			2	1	1					4
TOTAL.....		71	233	434	100	151	62	116	8	26	1201

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16 - 3 8/16.....										
90-95	3 9/16 - 3 12/16.....		1			1					2
96-101	3 13/16 - 4.....	1	8	4	1	2		2	1	2	21
102-107	4 - 4 3/16.....	9	31	63	15	15	9	13	1	1	157
108-113	4 4/16 - 4 7/16.....	10	32	70	15	13	16	18	1	5	180
114-119	4 8/16 - 4 11/16.....	2	15	23	1	8	1	8			58
120-125	4 12/16 - 4 15/16.....			2	1	1	2				6
TOTAL.....		22	87	162	33	40	28	41	3	8	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16 - 3 8/16.....										
90-95	3 9/16 - 3 12/16.....										
96-101	3 13/16 - 4.....			1							1
102-107	4 - 4 3/16.....		5	7	1	1	2	2		1	19
108-113	4 4/16 - 4 7/16.....	4	9	11	7	3		3		1	38
114-119	4 8/16 - 4 11/16.....	1	6	7	3	3		3		1	24
120-125	4 12/16 - 4 15/16.....		1		1	1	1	1		1	6
TOTAL.....		5	21	26	12	8	3	9		4	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16 - 3 8/16.....										
90-95	3 9/16 - 3 12/16.....										
96-101	3 13/16 - 4.....										
102-107	4 - 4 3/16.....	1		1	1						3
108-113	4 4/16 - 4 7/16.....			1						1	2
114-119	4 8/16 - 4 11/16.....	1	3	1			1	1			7
120-125	4 12/16 - 4 15/16.....					1					1
TOTAL.....		2	3	3	1	1	1	1		1	13

if the length of his foot placed on a shoe measuring scale fell either slightly short or slightly over the actual size mark. Accordingly, the foot measurements in this study were grouped so that the central measurement for any size was just beyond the midpoint between two sizes on the size scale. Some errors are inherent in this method since one size group may be excessively weighted while the adjacent size group may include too few individuals. However, a comparison, as shown in Fig. 25, reveals that the size distribution of the white subjects studied very closely approximates that of the total Army.

OPINION OF HQ., ARMY GROUND FORCES - Inquiry was addressed to Army Ground Forces to ascertain whether white inductees in training at Fort Knox during

the period of the study were representative of inductees into the Army generally at that time. From the reply, which follows, it appears that the physical ratings of Armored trainees tend to be inferior to those of the Infantry but superior to those of other arms, on the average. It is not known to what extent this may influence foot dimensions.

C HEADQUARTERS, ARMY GROUND FORCES  
O Washington, D. C.  
P  
Y

354.1 (ARTC) (16 Jan 46) GNACR 1st Ind 26 Jan 1946

HEADQUARTERS ARMY GROUND FORCES, Washington 25, D. C., 25 January 1946.

TO: COMMANDING OFFICER, Armored Medical Research Laboratory, Fort Knox, Kentucky

1. This headquarters does not regard personnel sent to ARTC, Fort Knox, Kentucky, during October and November 1945, as a cross section of the inductees during that period. The age grouping, indicated in basic communication, is typical of all the men inducted during that period.

2. Army Ground Forces is permitted to select the best physically qualified inductees and unassigned enlistees for its training centers. During the period in question, Army Ground Forces received approximately 37% of all white enlistees and inductees and 97% of these were "A" profile men. The Army Ground Forces liaison officers at reception centers have been instructed to place the best qualified of the personnel, received by Army Ground Forces, in the Infantry, and to spread the balance evenly among the other Army Ground Forces arms; including the Armored. About 55% of all personnel received by Army Ground Forces during October and November 1945, for replacement training, was sent to the Infantry.

3. There have been no studies made by this headquarters as to the comparative physiques of the trainees in the various arms, nor is it known by the War Department that such studies, comparing the trainees of the 3 Major Commands, were in process. However, the following assumptions may be made:

a. That the Armored trainee is not the physical equal of the Infantry trainee.

b. That the Armored trainee has a better physique than the Army Service Forces and Army Air Forces trainee.

c. That the lower extremities of the Armored trainee are poorer than those of the Infantry trainee, but better than those of the average Army Service Forces or Army Air Forces trainee.

4. Because of its centralized location in that area, Fort Knox receives its men from the Central and Eastern portions of the United States.

BY COMMAND OF GENERAL DEVERS:

/s/ G. H. Farnham  
G. H. FARNHAM  
Major, A.G.D.  
Asst. Ground Adj. Gen.



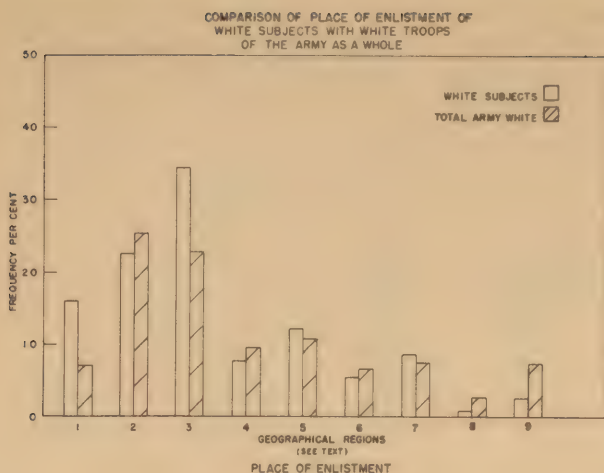


Figure 23

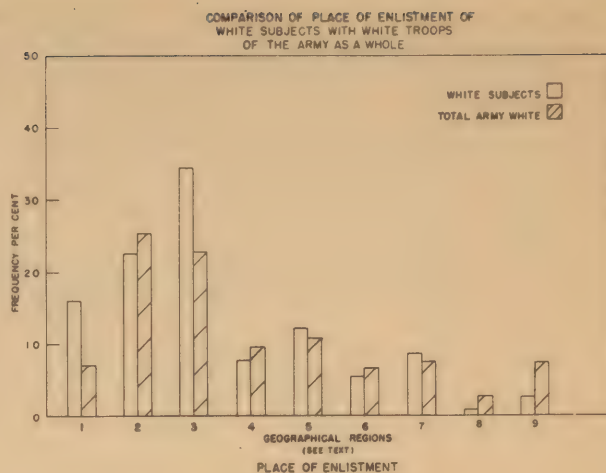


Figure 24

### C. THE NEGRO SUBJECTS

Inasmuch as the Negro subjects available for study were Air Corps personnel it might be assumed that they would differ in physical characteristics from the general Negro population of the country. This is a highly complex problem to evaluate. It was decided to measure certain of the facial dimensions of the Negro subjects and to compare these with similar measurements of other groups of Negroes. Dr. W. Montague Cobb participated in and supervised this part of the project, the results of which are indicated below. The facial measurements recorded were:

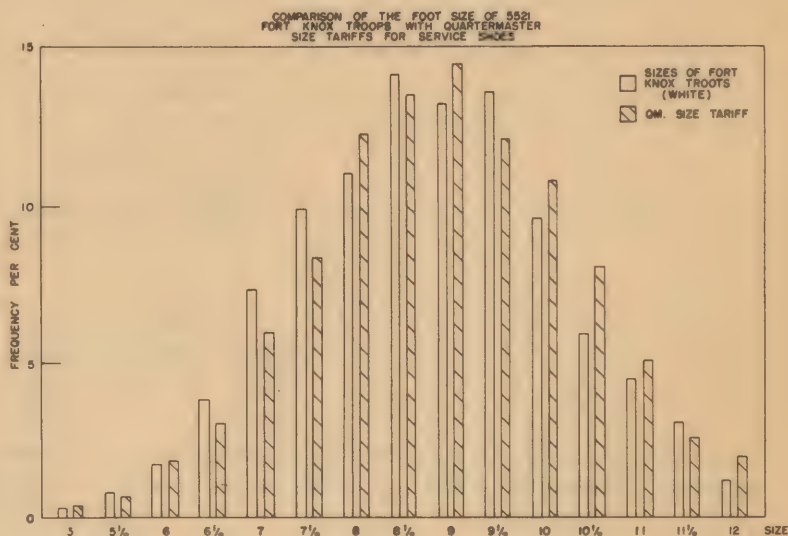
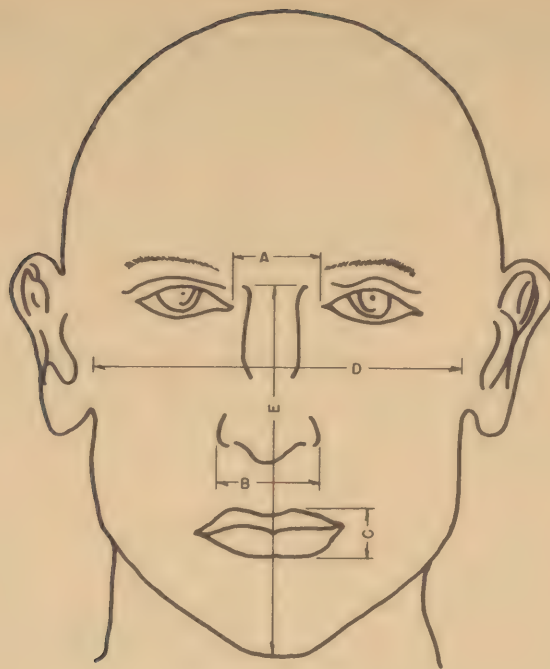


Figure 25

1. Interocular distances. Distance between internal canthi, measured with sharp ends of sliding calipers. (Fig. 26A)

2. Nasal breadth. Greatest horizontal distance between undistended alae of nose, measured with blunt ends of sliding calipers. (Fig. 26B)

3. Lip thickness. Greatest vertical distance between junctions of mucous and integumentary portions of upper and lower lips, measured with blunt ends of sliding calipers. (Fig. 26C)



- A. INTERORBITAL DISTANCE
- B. NASAL BREADTH
- C. LIP THICKNESS
- D. FACIAL (BIZYGOMATIC) BREADTH
- E. FACIAL HEIGHT (NASION - MENTON DISTANCE)

Figure 26  
Facial Measurements  
Recorded on Negroes

4. Facial (bizygomatic) breadth. Greatest breadth of face over malar arches, measured with spreading calipers. The tips of the calipers are placed over the zygomatic processes of the temporal bones just in front of the ears and are drawn evenly forward without compressing the skin. The breadth is the point of greatest spread of the calipers. (Fig. 26D)

5. Facial Height. Nasion-menton distance or distance from root of nose to point of chin, measured with blunt ends of sliding calipers. The nasion is taken as a midline point on a horizontal tangent to the superior palpebral sulcus. (Fig. 26E)

In Table 7 these measurements are compared with similar measurements made by the Air Corps in connection with the fitting of face masks to Negro flyers (7) and with measurements on three groups of Negro civilians (8).

- (7) Anthropometric Facial Survey at Wiberforce Univ., Air Corps Materiel Div., Serial No. Exp-M-49-695-4, July 7, 1942.
- (8) "The Physical Form of Mississippi Negroes" Herskovitz, Cameron & Smith, American Journal of Physical Anthropology 16, 193, 1931



TABLE 7

COMPARISON OF FACIAL MEASUREMENTS OF ADULT  
MALE NEGROES IN THIS STUDY WITH  
THOSE OF OTHER STUDIES

FACIAL MEASUREMENT	This Study (1200 Subjects)			Wilberforce (7) (132 Subj.)		Amory (8) (156 Subj.)		General (8) (961 Subj.)		Howard Univ (8) (535 Subj.)	
	Range	Mean	S.D.	Range	Mean	Mean	S.D.	Mean	S.D.	Mean	S.D.
I Interorbital Distance	22.0 - 45.0	33.9	2.91	26.0 - 42.0	35.0	-	-	-	-	-	-
II Nasal Breadth	24.0 - 53.0	41.4	3.48	34.0 - 53.0	42.0	41.5	4.35	40.9	3.99	41.0	3.8
III Lip Thickness	13.0 - 39.0	26.5	3.69	-	-	21.0	5.14	21.2	4.50	22.3	4.4
IV Facial Height	102.0 - 155.0	123.2	6.33	112.0 - 152.0	126.0	122.5	7.88	-	-	122.6	6.3
V Facial Breadth	116.0 - 158.0	134.1	6.69	128.0 - 157.0	143.0	138.5	5.20	139.2	5.92	139.1	6.2

W

8



ANALYSIS OF THE DIMENSIONAL DATA

The measurements of all white and Negro subjects have been assembled and analyzed according to a systematic plan. A complete set of information is presented as a unit for each dimension according to the following scheme:

Plan of Presentation For Each Set of Measurements.

1. An illustration of the location and method of measuring.
2. A chart showing the distribution of measurements for whites and Negroes.
3. A table indicating the means and ranges of measurements for whites and Negroes. The close correspondence of the 98% and 95% ranges and their difference from the 100% range indicate the degree of homogeneity of most of the population for any particular dimension. The difference between 100% range and the 98% range is descriptive of the extreme 1% of the population at either end of the range.
4. Where appropriate, trivariate distribution tables indicating in an approximate manner the degree of correlation of each of the measurements with length and breadth of the foot have been prepared. The modal groups are underscored in each of these tables.
5. A chart to show the scatter of duplicate measurements for each dimension. This is to be interpreted as evidence of the precision with which each of the dimensions may be measured.
6. Charts to indicate the comparison of measurements on the right and left foot for five selected representative dimensions.
7. Interpretative notes.

An anatomical order of arrangement of the measurement data has been followed for convenience of presentation. The sequence utilized is as follows:

Length

1. Foot Length
2. Ball Length
3. 5th Toe Length
4. Outside Ball Length
5. Outside Ball Length (diagonal)

Toe Region

6. Toe Length
7. Breadth of 3 forward Toes
8. Toe Height
9. Height of Great Toe Tip
10. Anterior Curvature and Orientation of Toes

Metatarsal Region

11. Foot Breadth (diagonal)
12. Foot Breadth (horizontal)
13. Foot Flare

14. Ball Girth
15. Ball Height
16. Outside Ball Height
17. Angular Relationship of Metatarsal Heads to Heel
18. Lateral Foot Contour

Instep Region

19. Plantar Arch Height
20. Dorsal Arch Height
21. Breadth of Instep
22. Instep Girth

Posterior Region of Foot

23. Heel Breadth
24. Posterior Heel Contour
25. Diagonal Ankle Girth
26. Ankle Length
27. Lower Leg Girth

## FOOT LENGTH

**GENERAL** - This dimension was measured from a photograph of the sole as illustrated (Fig. 27). 98% of the white population fall within a range of 2-3/16 in. The Negro measurements tend to be larger than those of the white subjects (Fig. 28, Table 8). The distribution of foot lengths according to the conventional shoe size intervals is shown in App 3, Fig. 25.

**CORRELATIONS** - A coefficient of correlation has been computed for the relationship between foot length and breadth. Its value is:  $r = .54 \pm .01$ . This implies a tendency for longer feet to be wider and shorter feet to be narrower, but the correlation is far from perfect.

**DUPLICATE MEASUREMENTS** - The algebraic mean of the differences between duplicate measurements was found to be  $-.2$  mm., and the absolute mean difference without regard to sign was 1.6 mm. The range of the differences is shown as the continuous line in Fig. 29.

**DIFFERENCES BETWEEN RIGHT AND LEFT FOOT** - The mean left foot length was 0.48 mm. longer than the mean right foot length. The distribution of the differences between the measurements of the right and left foot are shown by the broken line in Fig. 29, where they are compared with the differences between the duplicate measurements on the same foot.



Figure 27  
Foot length

TABLE 8  
FOOT LENGTH

No. Subjects	WHITE 5574		NEGRO 1200	
	mm.	in.	mm.	in.
Mean .....	268.4	10 9/16	275.5	10 14/16
100% range . .	229-315	9 - 12 6/16	239-321	9 7/16 - 12 10/16
98% range . .	242-296	9 8/16 - 11 11/16	247-303	9 12/16 - 11 15/16
95% range . .	246-291	9 11/16 - 11 7/16	251-300	9 14/16 - 11 13/16



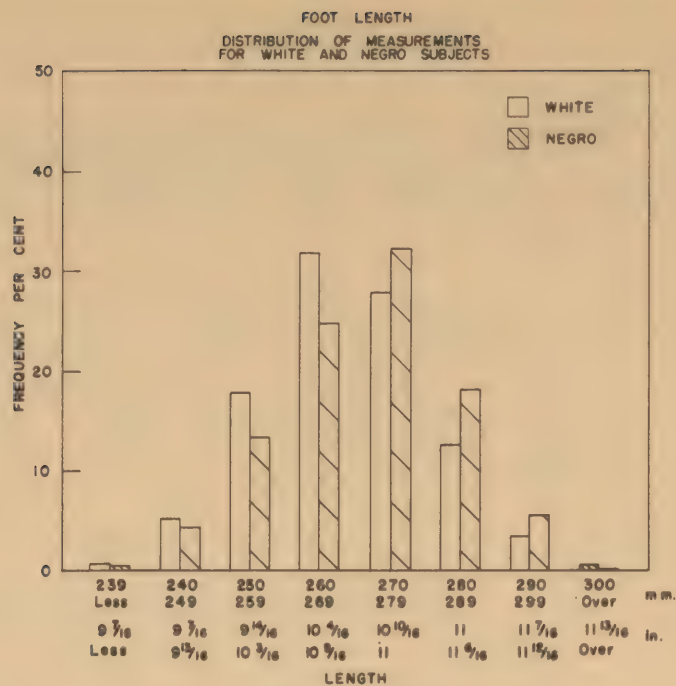


Figure 28

FOOT LENGTH  
DISTRIBUTION OF DIFFERENCES BETWEEN DUPLICATE  
MEASUREMENTS ON 199 SUBJECTS COMPARED WITH DIFFERENCE  
BETWEEN RIGHT AND LEFT FOOT MEASUREMENTS ON 5571 SUBJECTS

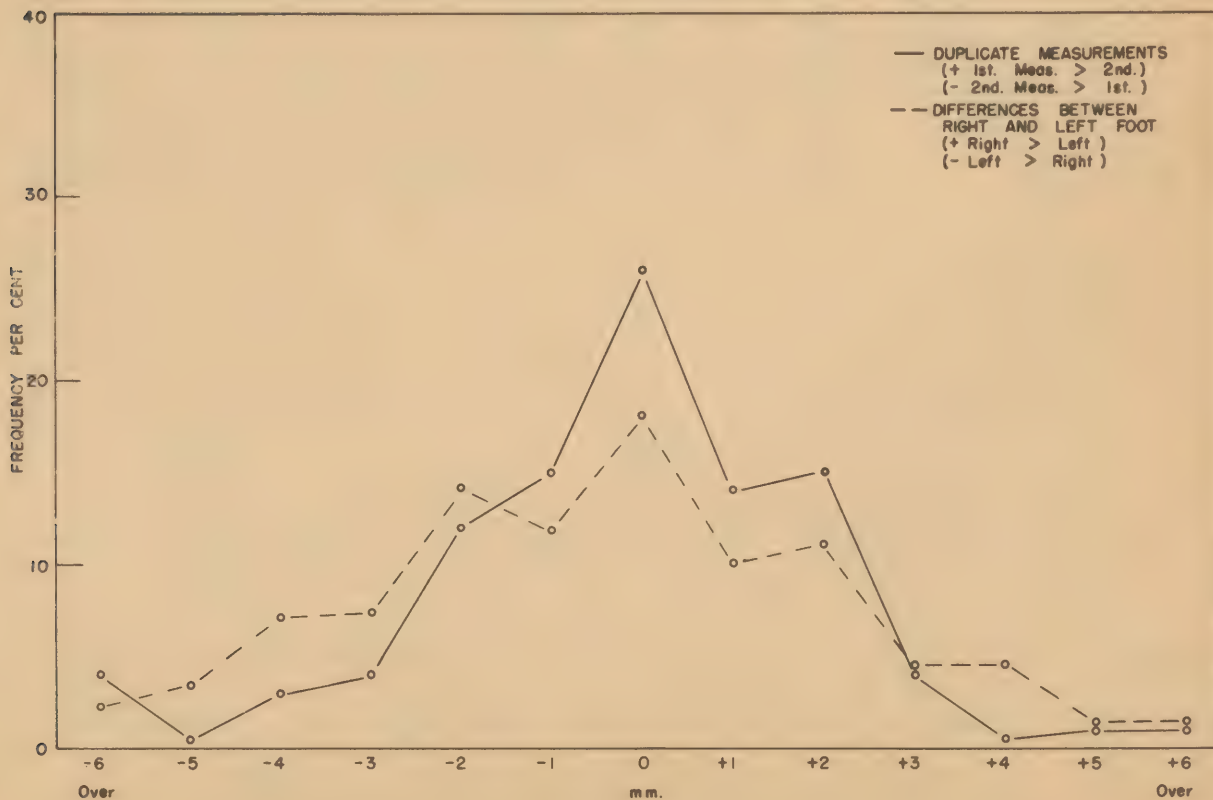


Figure 29

## BALL LENGTH

GENERAL - This dimension was measured from a photograph of the sole as illustrated (Fig. 30). 98% of the white population is included within a range of  $1 \frac{11}{16}$  in. The Negro measurements tend to be larger than those of the white subjects (Fig. 31, Table 9).



Figure 30  
Ball Length

CORRELATIONS - Ball length correlates only moderately well with foot length and poorly, if at all, with breadth. There is a pronounced scatter of the measurements, such that a given foot length may be associated with a wide variety of ball lengths (Table 10).

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be +0.4 mm., and the absolute mean difference without regard to sign was 2.7 mm. The range of differences is shown as the continuous line in Fig. 32.

DIFFERENCES BETWEEN RIGHT AND LEFT FOOT - The mean left foot length was 1.48 mm. longer than the mean right foot length. The distribution of the differences between the measurements of the right and left foot are shown by the broken line in Fig. 32, where they are compared with the differences between the duplicate measurements on the same foot.

TABLE 9

### BALL LENGTH

No. Subjects	WHITE 5575		NEGRO 1199	
	mm.	in.	mm.	in.
Mean	192.6	$7 \frac{10}{16}$	201.4	$7 \frac{15}{16}$
100% range	161-226	$6 \frac{5}{16} - 8 \frac{14}{16}$	168-238	$6 \frac{10}{16} - 9 \frac{6}{16}$
98% "	172-214	$6 \frac{12}{16} - 8 \frac{7}{16}$	178-225	7 - $8 \frac{14}{16}$
95% "	175-211	$6 \frac{14}{16} - 8 \frac{5}{16}$	182-221	$7 \frac{3}{16} - 8 \frac{11}{16}$



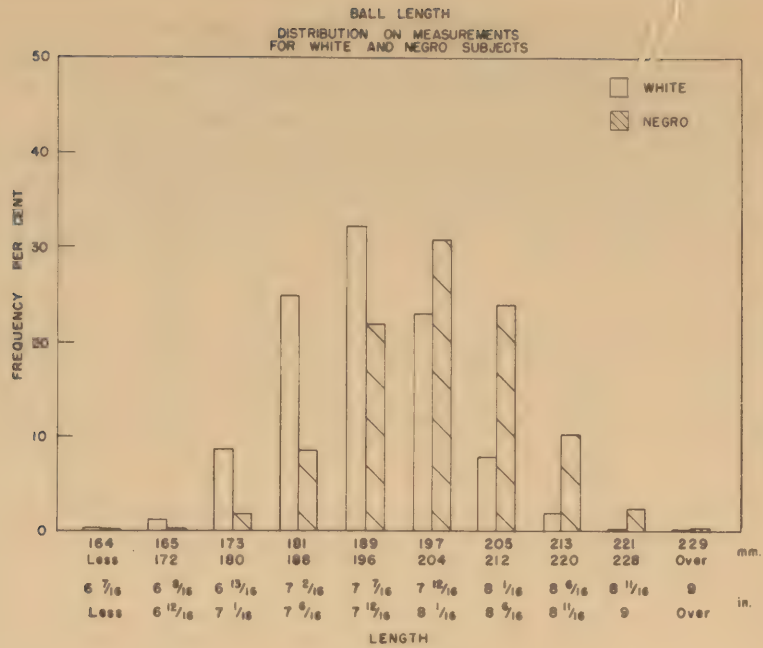


Figure 31

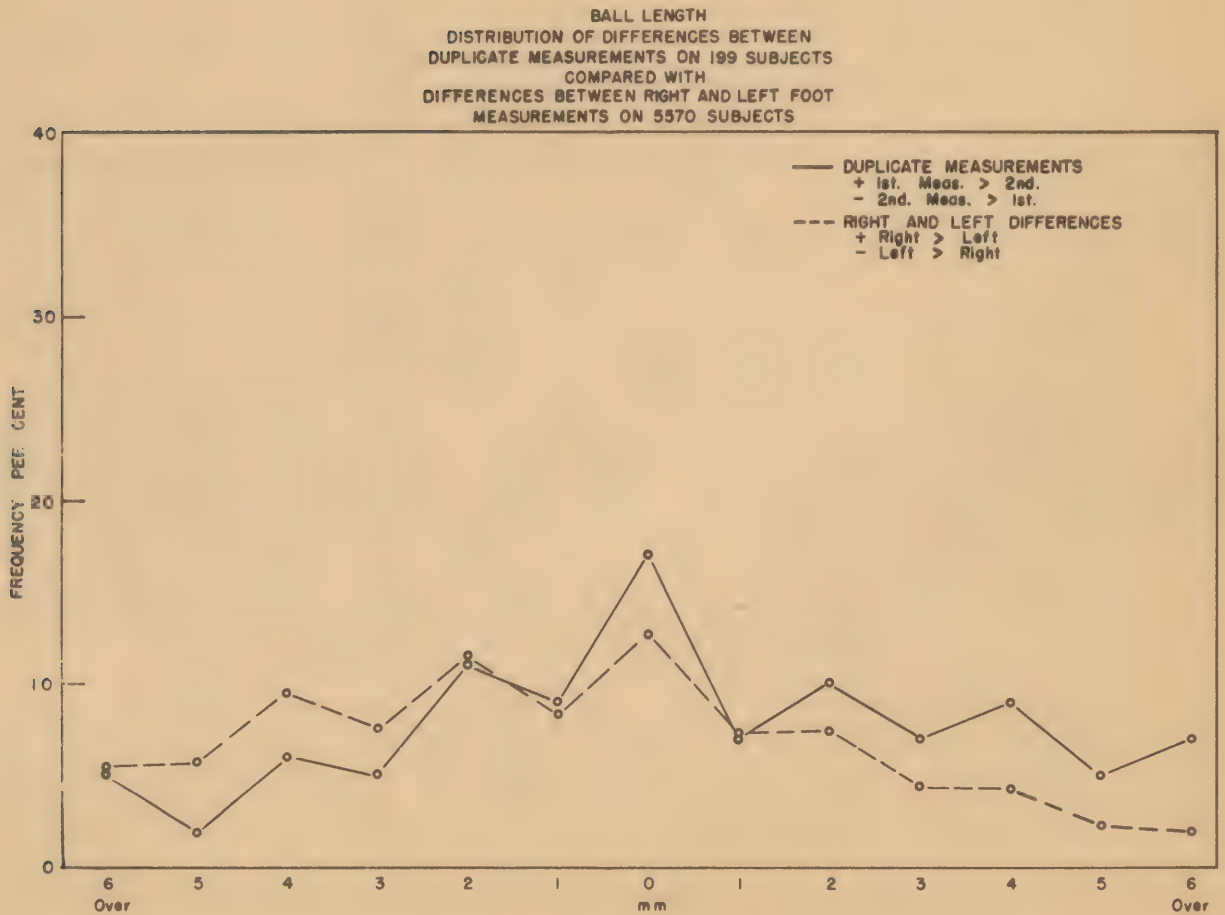


Figure 32

TABLE 10  
CORRELATION BETWEEN BALL LENGTH AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (18 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		BALL LENGTH										TOTAL
		mm. 164- Less	165- 172	173- 180	181- 188	189- 196	197- 204	205- 212	213- 220	221- 228	229- Over	
		in. 6 7/16 & Less	6 8/16- 6 12/16	6 13/16- 7 1/16	7 2/16- 7 6/16	7 7/16- 7 12/16	7 12/16- 8 1/16	8 1/16- 8 6/16	8 6/16- 8 11/16	8 11/16- 9"	9" & Over	
mm.	in.											
84-89	3 5/16-3 8/16..											
90-95	3 9/16-3 12/16..	1	1									2
96-101	3 13/16-4".....		1	2								3
102-107	4"-4 3/16.....			1								1
108-113	4 4/16-4 7/16..											
114-119	4 8/16-4 11/16..											
120-125	4 12/16-4 15/16											
TOTAL.....		1	2	3								6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16..		2	4								6
90-95	3 9/16-3 12/16..	1	21	5								27
96-101	3 13/16-4".....	1	12	31	1							45
102-107	4"-4 3/16.....	1	2	6								9
108-113	4 4/16-4 7/16..											
114-119	4 8/16-4 11/16..											
120-125	4 12/16-4 15/16											
TOTAL.....		3	37	46	1							87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16..			2								2
90-95	3 9/16-3 12/16..		2	52	30							84
96-101	3 13/16-4".....	3	12	190	119	2						326
102-107	4"-4 3/16.....		5	71	51	1						128
108-113	4 4/16-4 7/16..			2	6	3						11
114-119	4 8/16-4 11/16..			1	2							3
120-125	4 12/16-4 15/16											
TOTAL.....		3	19	318	208	6						554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16..					1						1
90-95	3 9/16-3 12/16..			7	45	14						66
96-101	3 13/16-4".....		1	62	438	160	4					665
102-107	4"-4 3/16.....		1	37	348	171	3					560
108-113	4 4/16-4 7/16..			8	40	34	1					83
114-119	4 8/16-4 11/16..			1	2	2						5
120-125	4 12/16-4 15/16											
TOTAL.....			2	115	873	382	8					1380

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16..											
90-95	3 9/16-3 12/16..				4	17	3					24
96-101	3 13/16-4".....	37	1	1	86	301	49					475
102-107	4"-4 3/16.....			1	160	657	186	1				1005
108-113	4 4/16-4 7/16..				42	162	77	3				284
114-119	4 8/16-4 11/16..				1	3	7	11				22
120-125	4 12/16-4 15/16											
TOTAL.....		37	1	2	293	1140	322	15				1810



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		BALL LENGTH										TOTAL
		mm. 164- Less	165- 172	173- 180	181- 188	189- 196	197- 204	205- 212	213- 220	221- 228	229- Over	
		in. 6 7/16 & Less	6 8/16- 6 12/16	6 13/16- 7 1/16	7 2/16- 7 6/16	7 7/16- 7 12/16	7 12/16- 8 1/16	8 1/16- 8 6/16	8 6/16- 8 11/16	8 11/16- 9"	9" & Over	
mm.	in.											
84-89	3 5/16-3 8/16..											
90-95	3 9/16-3 12/16.					3	5					8
96-101	3 13/16-4"				1	38	123	16				178
102-107	4"-4 3/16.....				3	142	410	63	1			618
108-113	4 4/16-4 7/16..				3	64	216	60	4			347
114-119	4 8/16-4 11/16.				1	6	27	12				46
120-125	4 12/16-4 15/16						3	1				4
TOTAL.....					8	253	784	152	5			1202

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..											
90-95	3 9/16-3 12/16.					1			1			2
96-101	3 13/16-4"						8	12	1			21
102-107	4"-4 3/16.....					2	48	96	11			157
108-113	4 4/16-4 7/16..					1	48	114	17			180
114-119	4 8/16-4 11/16.						13	35	8	2		58
120-125	4 12/16-4 15/16						1	1	4			6
TOTAL.....						4	118	258	42	2		424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16..											
90-95	3 9/16-3 12/16.											
96-101	3 13/16-4"							1				1
102-107	4"-4 3/16.....						1	8	10			19
108-113	4 4/16-4 7/16..						2	9	24	3		38
114-119	4 8/16-4 11/16.							9	15			24
120-125	4 12/16-4 15/16						3	3				6
TOTAL.....							6	30	49	3		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..											
90-95	3 9/16-3 12/16.											
96-101	3 13/16-4"											
102-107	4"-4 3/16.....									3		3
108-113	4 4/16-4 7/16..								1	1		2
114-119	4 8/16-4 11/16.								2	5		7
120-125	4 12/16-4 15/16								1			1
TOTAL.....									4	9		13

## 5TH TOE LENGTH

**GENERAL** - This dimension was measured from a photograph of the sole as illustrated (Fig. 33). 98% of the white population is included within a range of  $1 \frac{14}{16}$  in. The Negro measurements tend to be larger than those of the white subjects (Fig. 34, Table 11).



Figure 33  
5th Toe Length

**CORRELATIONS** - The 5th toe length correlates only moderately well with foot length and poorly, if at all, with breadth. There is a pronounced scatter of the measurements, such that a given foot length may be associated with a wide variety of 5th toe lengths (Table 12).

**DUPLICATE MEASUREMENTS** - The algebraic mean of the differences between duplicate measurements was found to be  $-0.3$  mm., and the absolute mean difference without regard to sign was  $2.8$  mm. The range of differences is shown in Fig. 35.

TABLE 11

### 5TH TOE LENGTH

WHITE No. Subjects 5568			NEGRO 1198	
	mm.	in.	mm.	in.
Mean .....	209.5	$8 \frac{4}{16}$	216.7	$8 \frac{9}{16}$
100% range . .	170-256	$6 \frac{11}{16} - 10 \frac{1}{16}$	184-256	$7 \frac{4}{16} - 10 \frac{1}{16}$
98% range . .	186-233	$7 \frac{5}{16} - 9 \frac{3}{16}$	192-242	$7 \frac{9}{16} - 9 \frac{8}{16}$
95% range . .	189-229	$7 \frac{7}{16} - 9$	196-237	$7 \frac{12}{16} - 9 \frac{5}{16}$



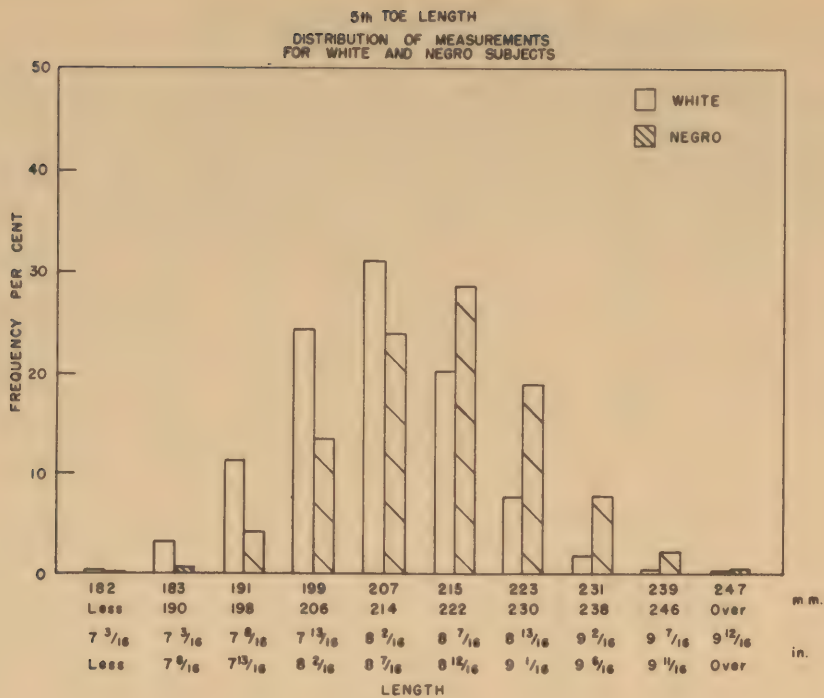


Figure 34

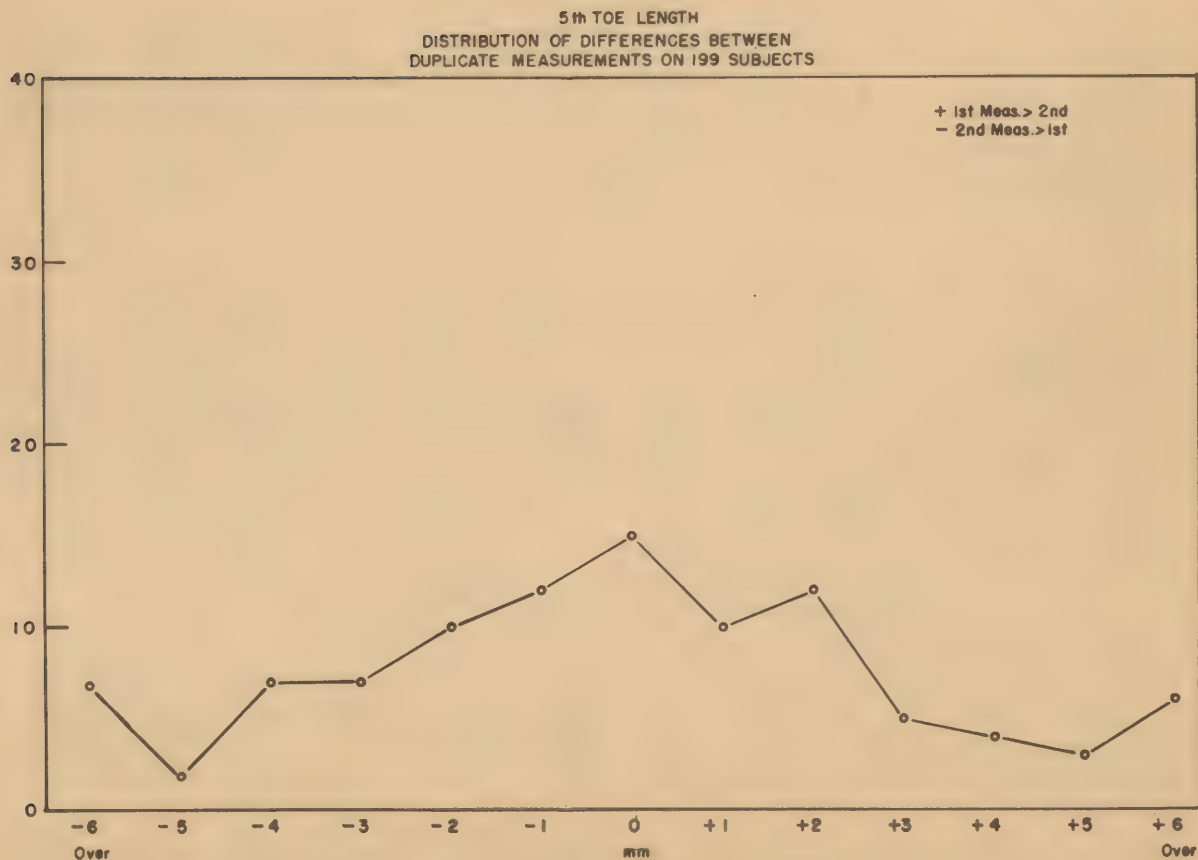


Figure 35

TABLE 12  
CORRELATION BETWEEN 5TH TOE LENGTH AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		5TH TOE LENGTH										TOTAL
		mm. 182- Less	183- 190	191- 198	199- 206	207- 214	215- 222	223- 230	231- 238	239- 246	247- Over	
mm.	in.	in. 7 3/16 & Less	7 3/16- 7 8/16	7 8/16- 7 13/16	7 13/16- 8 2/16	8 2/16- 8 7/16	8 7/16- 8 12/16	8 13/16- 9 1/16	9 2/16- 9 6/16	9 7/16- 9 11/16	9 12/16 & Over	
84-89	3 5/16-3 8/16..											2
90-95	3 9/16-3 12/16.		2									2
96-101	3 13/16-4.....	1	1	1								3
102-107	4-4 3/16.....			1								1
108-113	4 4/16-4 7/16..											
114-119	4 8/16-4 11/16.											
120-125	4 12/16-4 15/16.											
TOTAL.....		1	3	2								6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16..	1	4	1								6
90-95	3 9/16-3 12/16.	2	13	12								27
96-101	3 13/16-4.....	8	<u>19</u>	17	1							<u>45</u>
102-107	4-4 3/16.....		<u>3</u>	6								<u>9</u>
108-113	4 4/16-4 7/16..											
114-119	4 8/16-4 11/16.											
120-125	4 12/16-4 15/16.											
TOTAL.....		11	<u>39</u>	36	1							87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16..			2								2
90-95	3 9/16-3 12/16.	1	20	<u>37</u>	22	1		1			1	84
96-101	3 13/16-4.....	3	55	<u>155</u>	103	9		1		1		<u>326</u>
102-107	4-4 3/16.....	1	21	<u>67</u>	32	6						<u>127</u>
108-113	4 4/16-4 7/16..		2	<u>4</u>	4	1						11
114-119	4 8/16-4 11/16.		1		2							3
120-125	4 12/16-4 15/16.											
TOTAL.....		5	99	<u>265</u>	163	17		2		1	1	553

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16..				1							1
90-95	3 9/16-3 12/16.			17	<u>32</u>	16	1					66
96-101	3 13/16-4.....		16	124	<u>339</u>	168	15	2			1	<u>665</u>
102-107	4-4 3/16.....		12	114	<u>281</u>	137	13					<u>557</u>
108-113	4 4/16-4 7/16..		2	15	<u>43</u>	18	4		1			83
114-119	4 8/16-4 11/16.			1	<u>3</u>	1						5
120-125	4 12/16-4 15/16.											
TOTAL.....			30	271	<u>699</u>	340	33	2	1		1	1377

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16..											
90-95	3 9/16-3 12/16.			2	8	11	3					24
96-101	3 13/16-4.....	1	1	14	116	<u>250</u>	90	3				475
102-107	4-4 3/16.....		1	31	224	<u>543</u>	190	15				<u>1004</u>
108-113	4 4/16-4 7/16..		1	11	75	<u>145</u>	49	5				<u>286</u>
114-119	4 8/16-4 11/16.				3	<u>12</u>	6	1				22
120-125	4 12/16-4 15/16.											
TOTAL.....		1	3	58	426	<u>961</u>	338	24				1811



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		5TH TOE LENGTH										TOTAL	
		mm.	182- Less	183- 190	191- 198	199- 206	207- 214	215- 222	223- 230	231- 238	239- 246		247- Over
		in.	7 3/16 & Less	7 3/16- 7 8/16	7 8/16- 7 13/16	7 13/16- 8 2/16	8 2/16- 8 7/16	8 7/16- 8 12/16	8 13/16- 9 1/16	9 2/16- 9 6/16	9 7/16- 9 11/16		9 12/16 & Over
84-89	3 5/16-3 8/16..												
90-95	3 9/16-3 12/16.				5	3							8
96-101	3 13/16-4.....				10	63	82	21	1				177
102-107	4-4 3/16.....				32	196	310	74	4	1	1		618
108-113	4 4/16-4 7/16..				15	99	173	57	3				347
114-119	4 8/16-4 11/16.				3	13	17	13					46
120-125	4 12/16-4 15/16.					1	3						4
TOTAL.....					65	375	585	165	8	1	1		1200

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16.	.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	2
96-101	3 13/16-4.....	.....	.....	.....	.....	1	2	9	6	3	.....	.....	21
102-107	4-4 3/16.....	.....	.....	.....	.....	1	11	49	80	12	4	.....	157
108-113	4 4/16-4 7/16..	.....	.....	.....	.....	1	12	66	76	24	1	.....	180
114-119	4 8/16-4 11/16.	.....	.....	.....	.....	.....	3	21	26	7	1	.....	58
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	1	1	2	1	.....	.....	5
TOTAL.....	.....	.....	.....	.....	.....	3	29	147	191	47	6	.....	423

LENGTH GROUP 295 to 304 mm. (11 11/16 to 12 in.)

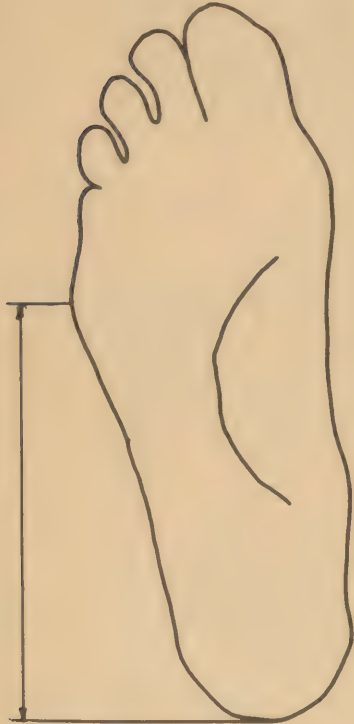
84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
96-101	3 13/16-4.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1
102-107	4-4 3/16.....	.....	.....	.....	.....	.....	.....	1	5	10	3	.....	19
108-113	4 4/16-4 7/16..	.....	.....	.....	.....	.....	.....	1	5	13	14	.....	38
114-119	4 8/16-4 11/16.	.....	.....	.....	.....	.....	.....	2	4	9	8	.....	24
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	4	2	.....	.....	6
TOTAL.....	.....	.....	.....	.....	.....	.....	.....	3	10	32	34	9	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
96-101	3 13/16-4.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
102-107	4-4 3/16.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....	.....	3
108-113	4 4/16-4 7/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	2
114-119	4 8/16-4 11/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	1	.....	3	2	.....	1
TOTAL.....	.....	.....	.....	.....	.....	.....	.....	1	3	5	4	.....	13

## OUTSIDE BALL LENGTH

GENERAL - This dimension was measured from a photograph of the sole as illustrated (Fig. 36). 98% of the white population is included within a range of  $1 \frac{11}{16}$  in. (Table 13). The Negro measurements tend to be larger than those of the white subjects (Fig. 37, Table 13).



CORRELATIONS - The outside ball length correlates only moderately well with foot length and poorly, if at all, with breadth. There is a pronounced scatter of the measurements, such that a given foot length may be associated with a wide variety of outside ball lengths (Table 14).

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be  $\pm 0.3$  mm., and the absolute mean difference without regard to sign was 3.5mm. The range of differences is shown in Fig. 38.

Figure 36  
Outside Ball Length

TABLE 13

### OUTSIDE BALL LENGTH

	No. Subjects	WHITE 5564		NEGRO 1198	
		mm.	in.	mm.	in.
Mean . . . . .		159.4	$6 \frac{4}{16}$	165.8	$6 \frac{9}{16}$
100% range . .	128-203		$5 \frac{1}{16} - 8$	134-200	$5 \frac{4}{16} - 7 \frac{14}{16}$
98% range . .	138-181		$5 \frac{7}{16} - 7 \frac{2}{16}$	143-189	$5 \frac{10}{16} - 7 \frac{7}{16}$
95% range . .	142-177		$5 \frac{9}{16} - 7$	147-185	$5 \frac{13}{16} - 7 \frac{5}{16}$



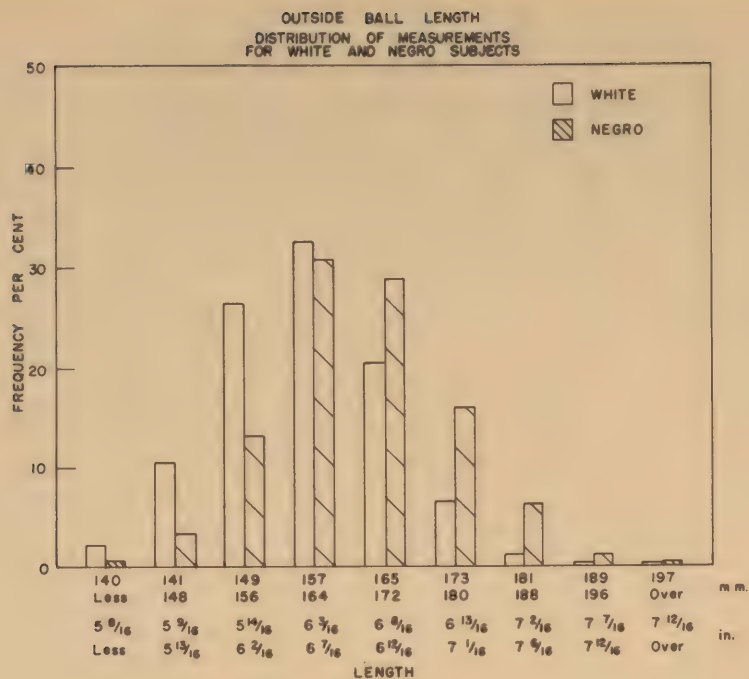


Figure 37

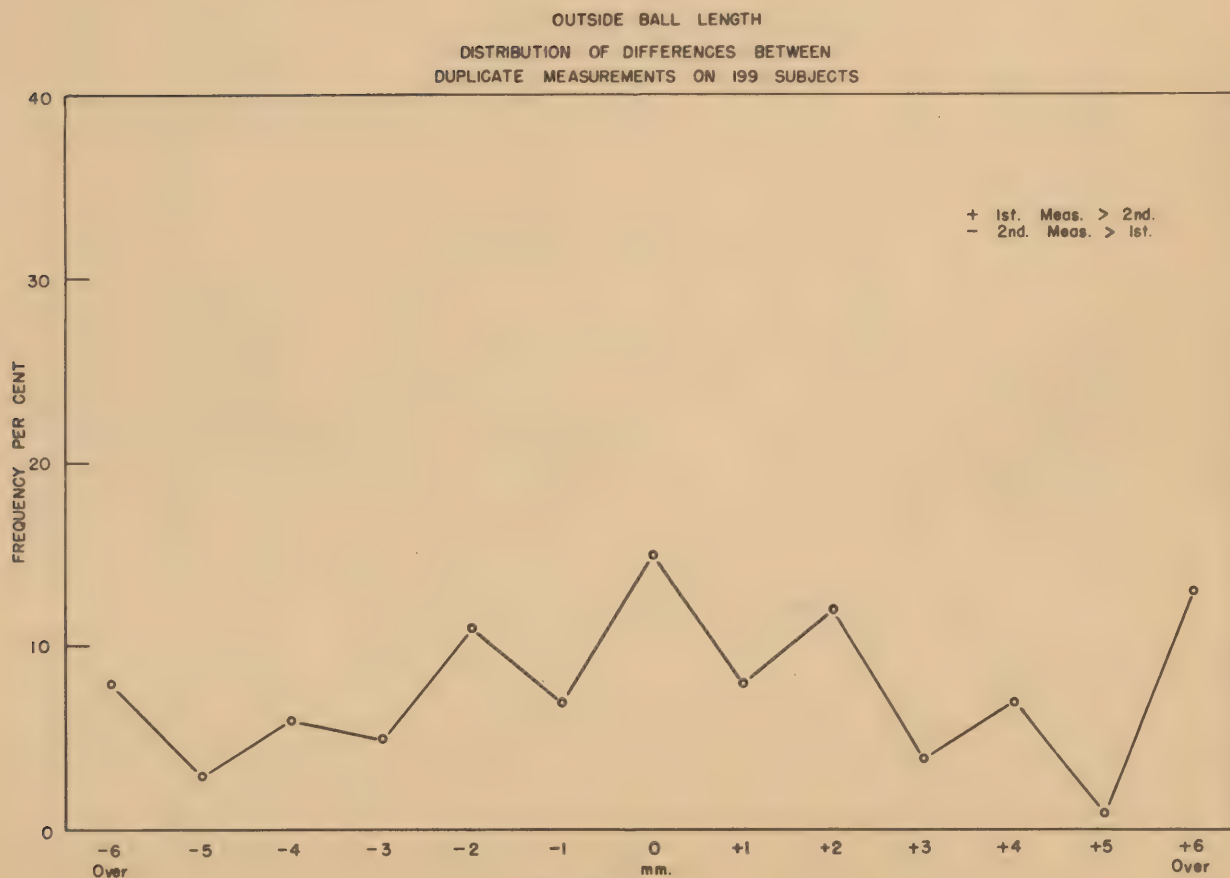


Figure 38

TABLE 14  
CORRELATION BETWEEN OUTSIDE BALL LENGTH AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		OUTSIDE BALL LENGTH									TOTAL
		mm. 140- Less	141- 148	149- 156	157- 164	165- 172	173- 180	181- 188	189- 196	197- Over	
		in. 5/8/16 & Less	5 8/16- & Less	5 9/16-5 13/16	5 14/16 6 2/16	6 3/16-6 12/16	6 13/16 7 1/16	7 1/16-7 6/16	7 7/16-7 12/16	7 12/16 & Over	
84-89	3 5/16-3 8/16.....										
90-95	3 9/16-3 12/16.....	1	1								2
96-101	3 13/16-4 .....	2		1							3
102-107	4 -4 3/16.....			1							1
108-113	4 4/16-4 7/16.....										
114-119	4 8/16-4 11/16.....										
120-125	4 12/16-4 15/16.....										
TOTAL.....		3	1	2							6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16.....	3	2	1							6
90-95	3 9/16-3 12/16.....	<u>13</u>	<u>11</u>	<u>3</u>							27
96-101	3 13/16-4 .....	<u>16</u>	<u>21</u>	<u>7</u>	1						<u>45</u>
102-107	4 -4 3/16.....	4	<u>5</u>								<u>9</u>
108-113	4 4/16-4 7/16.....										
114-119	4 8/16-4 11/16.....										
120-125	4 12/16-4 15/16.....										
TOTAL.....		36	<u>39</u>	11	1						87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16.....			2							2
90-95	3 9/16-3 12/16.....	6	28	37	11		1				83
96-101	3 13/16-4 .....	25	132	<u>149</u>	20						<u>326</u>
102-107	4 -4 3/16.....	22	<u>54</u>	<u>38</u>	12		1	1			<u>128</u>
108-113	4 4/16-4 7/16.....	1	<u>7</u>	2	1						11
114-119	4 8/16-4 11/16.....	1			2						3
120-125	4 12/16-4 15/16.....										
TOTAL.....		55	221	<u>228</u>	46		2	1			553

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16.....			1							1
90-95	3 9/16-3 12/16.....		5	29	24	8					66
96-101	3 13/16-4 .....	5	92	<u>315</u>	<u>210</u>	39	4				<u>665</u>
102-107	4 -4 3/16.....	13	129	<u>261</u>	133	20	1			2	<u>559</u>
108-113	4 4/16-4 7/16.....	3	27	<u>32</u>	18	3					83
114-119	4 8/16-4 11/16.....	1	3	<u>1</u>							5
120-125	4 12/16-4 15/16.....										
TOTAL.....		22	256	<u>639</u>	385	70	5			2	1379

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16.....										
90-95	3 9/16-3 12/16.....			4	<u>13</u>	7					24
96-101	3 13/16-4 .....	1	15	93	<u>245</u>	113	12		1		<u>475</u>
102-107	4 -4 3/16.....		31	303	<u>488</u>	167	20	1	1		<u>1063</u>
108-113	4 4/16-4 7/16.....	2	18	86	<u>132</u>	45	4		1		<u>288</u>
114-119	4 8/16-4 11/16.....		1	8	<u>10</u>	3					22
120-125	4 12/16-4 15/16.....										
TOTAL.....		3	65	494	<u>875</u>	335	36	1	3		1812

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		OUTSIDE BALL LENGTH									TOTAL	
		mm.	140- Less	141- 148	149- 156	157- 164	165- 172	173- 180	181- 188	189- 196		197- Over
		in.	5 8/16 & Less	5 8/16- & Less	5 9/16- 5 13/16	5 14/16 6 2/16	6 3/16- 6 12/16	6 13/16 7 1/16	7 1/16- 7 5/16	7 7/16- 7 12/16		7 12/16 & Over
84-89	3 5/16-3 8/16.....											
90-95	3 9/16-3 12/16.....					3	3	2			8	
96-101	3 13/16-4.....			1	7	58	91	19	2		178	
102-107	4 4 3/16.....		1	3	40	225	278	67	3	1	618	
108-113	4 4 1/16-4 7/16.....		1		34	133	142	33	3	1	347	
114-119	4 8/16-4 11/16.....				9	20	14	3			46	
120-125	4 12/16-4 15/16.....				2		2				4	
TOTAL.....			2	4	92	439	530	124	8	2	1201	

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16.....											
90-95	3 9/16-3 12/16.....						1	1				2
96-101	3 13/16-4.....					3	10	6	2			21
102-107	4 4 3/16.....				1	17	68	59	11	1		157
108-113	4 4 1/16-4 7/16.....				2	26	82	60	9	1		180
114-119	4 8/16-4 11/16.....					13	23	21	1			58
120-125	4 12/16-4 15/16.....					1	2	2		1		6
TOTAL.....					3	60	186	149	23	3		424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16.....						7					
90-95	3 9/16-3 12/16.....											
96-101	3 13/16-4.....						1					1
102-107	4 4 3/16.....						12	6	1			19
108-113	4 4 1/16-4 7/16.....						11	15	12			38
114-119	4 8/16-4 11/16.....					3	4	10	6	1		24
120-125	4 12/16-4 15/16.....						5		1			6
TOTAL.....						3	20	38	25	2		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16.....											
90-95	3 9/16-3 12/16.....											
96-101	3 13/16-4.....											
102-107	4 4 3/16.....							1	2			3
108-113	4 4 1/16-4 7/16.....							1	1	1		2
114-119	4 8/16-4 11/16.....						1	4	1	1		7
120-125	4 12/16-4 15/16.....							1				1
TOTAL.....							1	6	4	2		13



## OUTSIDE BALL LENGTH (DIAGONAL)

**GENERAL** - This dimension was measured from a photograph of the sole as illustrated (Fig. 39). 98% of the white population is included within a range of  $1 \frac{9}{16}$  in. (Table 15). The Negro measurements tend to be larger than those of the white subjects (Fig. 40, Table 15).



Figure 39

Outside Ball Length (Diagonal)

**CORRELATIONS** - The outside ball length (diagonal) correlates only moderately well with foot length and poorly, if at all, with breadth. There is a pronounced scatter of the measurements, such that a given foot length may be associated with a wide variety of outside ball lengths (diagonal) (Table 16).

**DUPLICATE MEASUREMENTS** - The algebraic mean of the difference between duplicate measurements was found to be +0.4 mm., and the absolute mean difference without regard to sign was 2.8 mm. The range of differences is shown in Fig. 44.

TABLE 15  
OUTSIDE BALL LENGTH (DIAGONAL)

No. Subjects	WHITE 5513		NEGRO 1199	
	mm.	in.	mm.	in.
Mean . . . . .	171.9	6 $\frac{12}{16}$	177.5	7
100% range . .	142-209	5 $\frac{9}{16}$ - 8 $\frac{4}{16}$	148-212	5 $\frac{13}{16}$ - 8 $\frac{6}{16}$
98% range . .	152-192	6 - 7 $\frac{9}{16}$	156-198	6 $\frac{2}{16}$ - 7 $\frac{13}{16}$
95% range . .	155-188	6 $\frac{2}{16}$ - 7 $\frac{6}{16}$	160-195	6 $\frac{5}{16}$ - 7 $\frac{11}{16}$

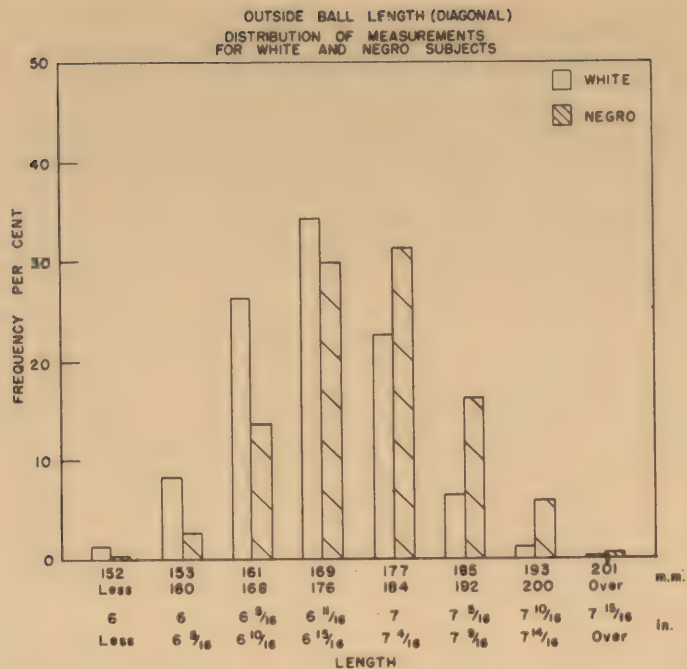


Figure 40

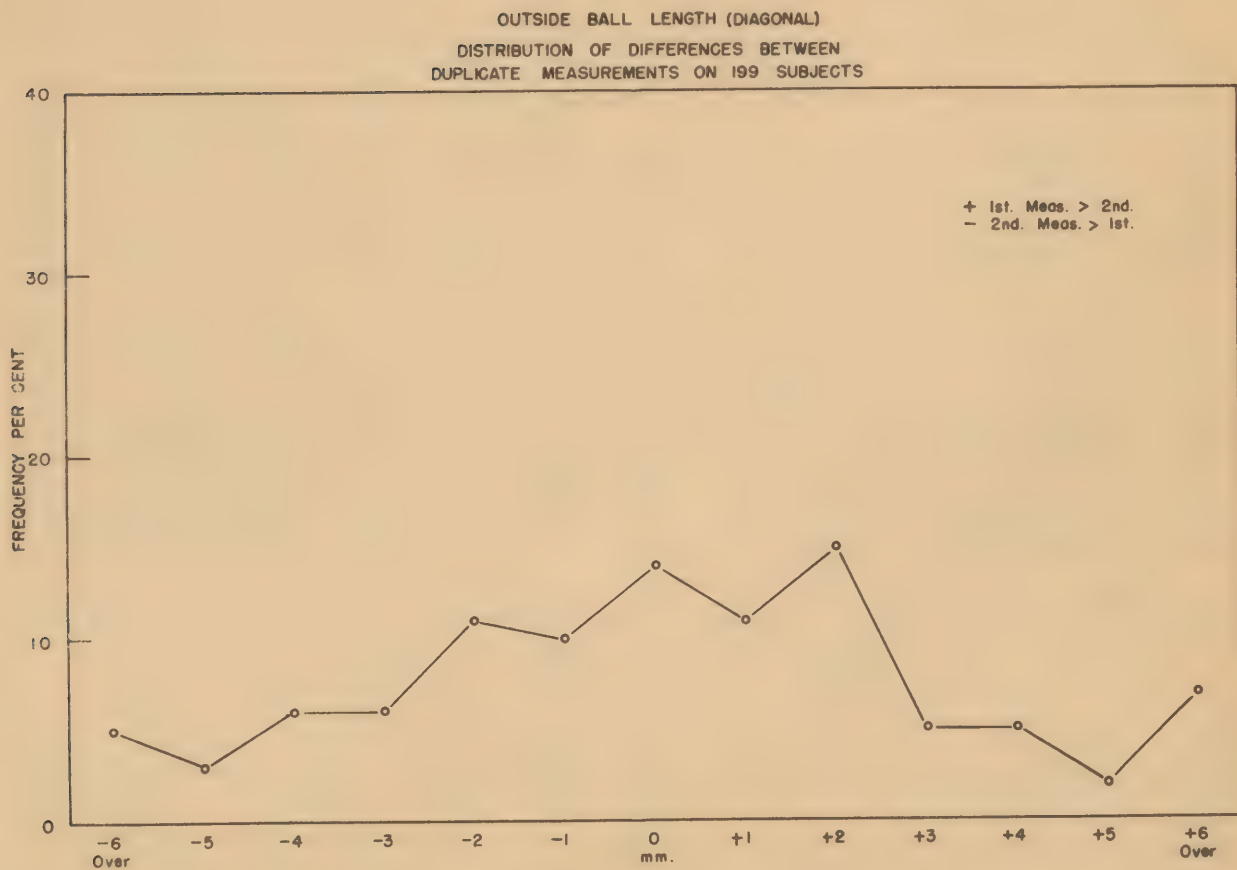


Figure 41

TABLE 16  
CORRELATION BETWEEN OUTSIDE BALL LENGTH (DIAGONAL) AND  
LENGTH AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		OUTSIDE BALL LENGTH (DIAGONAL)								TOTAL
		mm. 152- Less	153- 160	161- 168	169- 176	177- 184	185- 192	193- 200	201- Over	
		in. 6" & Less	6" - 6 5/16	6 5/16- 6 10/16	6 11/16- 6 15/16	7"- 7 4/16	7 5/16- 7 9/16	7 10/16- 7 14/16	7 15/16 & Over	
84-89	3 5/16-3 8/16...									
90-95	3 9/16-3 12/16..	1	1							2
96-101	3 13/16-4".....	2		1						3
102-107	4"-4 3/16.....			1						1
108-113	4 4/16-4 7/16...									
114-119	4 8/16-4 11/16..									
120-125	4 12/16-4 15/16.									
TOTAL.....		3	1	2						6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16...	3	3							6
90-95	3 9/16-3 12/16..	13	11	2	1					27
96-101	3 13/16-4".....	17	17	9	2					45
102-107	4"-4 3/16.....	3	6							9
108-113	4 4/16-4 7/16...									
114-119	4 8/16-4 11/16..									
120-125	4 12/16-4 15/16.									
TOTAL.....		36	37	11	3					87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16...		1			1				2
90-95	3 9/16-3 12/16..	2	31	46	5					84
96-101	3 13/16-4".....	12	143	142	18	5			1	321
102-107	4"-4 3/16.....	10	57	53	7					127
108-113	4 4/16-4 7/16...		6	4	1					11
114-119	4 8/16-4 11/16..		1	1	1					3
120-125	4 12/16-4 15/16.									
TOTAL.....		24	239	246	32	6			1	548

LENGTH GROUP 255 to 264 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16...			1						1
90-95	3 9/16-3 12/16..		4	36	20	6				66
96-101	3 13/16-4".....	2	74	339	216	22			1	654
102-107	4"-4 3/16.....	1	65	304	169	13	1			553
108-113	4 4/16-4 7/16...		15	45	18	3				81
114-119	4 8/16-4 11/16..		2	2		1				5
120-125	4 12/16-4 15/16.									
TOTAL.....		3	160	727	423	45	1		1	1360

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16...									
90-95	3 9/16-3 12/16..			3	15	5	1			24
96-101	3 13/16-4".....		12	75	269	107	10			473
102-107	4"-4 3/16.....		6	249	536	187	11	1		990
108-113	4 4/16-4 7/16...		8	65	156	56	2			287
114-119	4 8/16-4 11/16..			7	7	7				21
120-125	4 12/16-4 15/16.									
TOTAL.....			26	399	983	362	24	1		1795



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		OUTSIDE BALL LENGTH (DIAGONAL)								TOTAL
		mm. 152- Less	153- 160	161- 168	169- 176	177- 184	185- 192	193- 200	201- Over	
mm.	in.	in. 6" & Less	6" - 6 5/16	6 5/16- 6 10/16	6 11/16- 6 15/16	7"- 7 4/16	7 5/16- 7 9/16	7 10/16- 7 14/16	7 15/16 & Over	
84-89	3 5/16-3 8/16...									
90-95	3 9/16-3 12/16...				3	4	1			8
96-101	3 13/16-4"		1	5	60	92	20			178
102-107	4"-4 3/16...		1	26	209	304	72	1		613
108-113	4 4/16-4 7/16...		2	14	115	175	39	2		347
114-119	4 8/16-4 11/16...			4	18	19	5			46
120-125	4 12/16-4 15/16...	4								4
TOTAL.....		4	4	49	405	594	137	3		1196

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16...									
90-95	3 9/16-3 12/16...						1	1		2
96-101	3 13/16-4"				1	13	6	1		21
102-107	4"-4 3/16...			1	7	77	64	6	1	156
108-113	4 4/16-4 7/16...			1	23	88	59	7		178
114-119	4 8/16-4 11/16...			1	5	31	21			58
120-125	4 12/16-4 15/16...					3	3			6
TOTAL.....				3	36	212	154	15	1	421

LENGTH GROUPS 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16...									
90-95	3 9/16-3 12/16...									
96-101	3 13/16-4"						1			1
102-107	4"-4 3/16...					1	8	9	1	19
108-113	4 4/16-4 7/16...					8	17	12		37
114-119	4 8/16-4 11/16...					5	6	11	1	23
120-125	4 12/16-4 15/16...					2	3	1		6
TOTAL.....						16	35	33	2	86

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16...									
90-95	3 9/16-3 12/16...									
96-101	3 12/16-4"									
102-107	4"-4 3/16...						1	2		3
108-113	4 4/16-4 7/16...						1	1	1	2
114-119	4 8/16-4 11/16...				1		2	3	1	7
120-125	4 12/16-4 15/16...						1			1
TOTAL.....					1		4	6	2	1

# TOE LENGTH

GENERAL - This dimension was measured from a photograph of the sole as illustrated (Fig. 42). 98% of the white population is included within a range of 15/16 in. The Negro measurements tend to be smaller than those of the white subjects (Fig. 43, Table 17). Standard errors of the differences between compared means have not been computed routinely. However, in this instance in which the difference between the mean of the whites and Negroes is small (1.5 mm), the standard error was calculated and found to be 0.3698 mm. Thus the difference between the means is 4 times the standard error of the difference and is regarded as significant.



Figure 42  
Toe Length

CORRELATIONS - Toe length correlates only moderately well with foot length and poorly, if at all, with breadth. There is a pronounced scatter of the measurements, such that a given foot length may be associated with a wide variety of toe lengths (Table 18).

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be -0.6 mm., and the absolute mean difference without regard to sign was 2.7mm. The range of difference is shown in Fig. 44.

TABLE 17

## TOE LENGTH

No. Subjects	WHITE 5544		NEGRO 1198	
	mm.	in.	mm.	in.
Mean . . . . .	70.5	2 13/16	69.0	2 12/16
100% range . . .	50-94	2 - 3 11/16	51-88	2 - 3 7/16
98% " . . .	59-82	2 5/16 - 3 4/16	56-81	2 3/16 - 3 3/16
95% " . . .	61-80	2 6/16 - 3 2/16	58-79	2 5/16 - 3 2/16

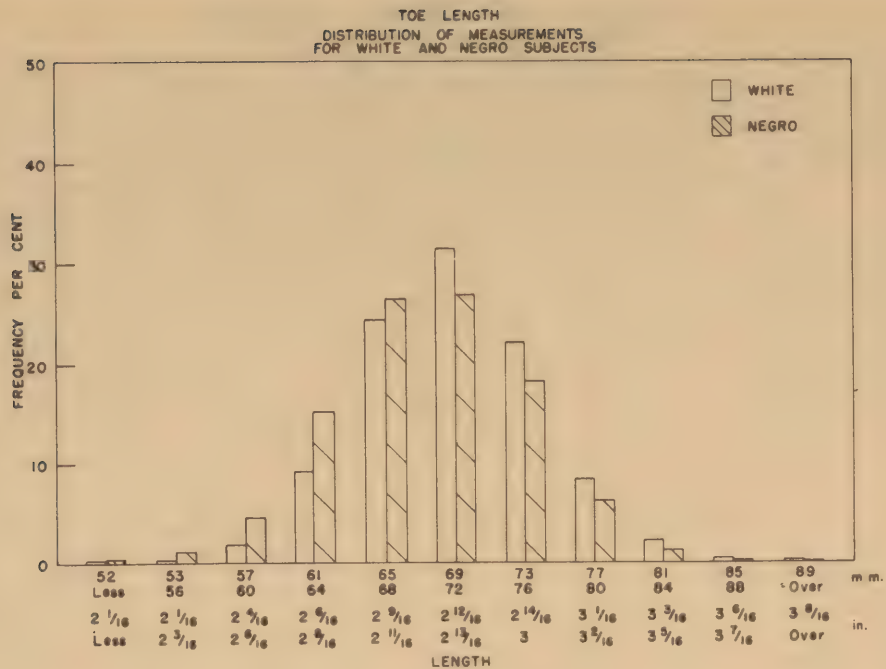


Figure 43

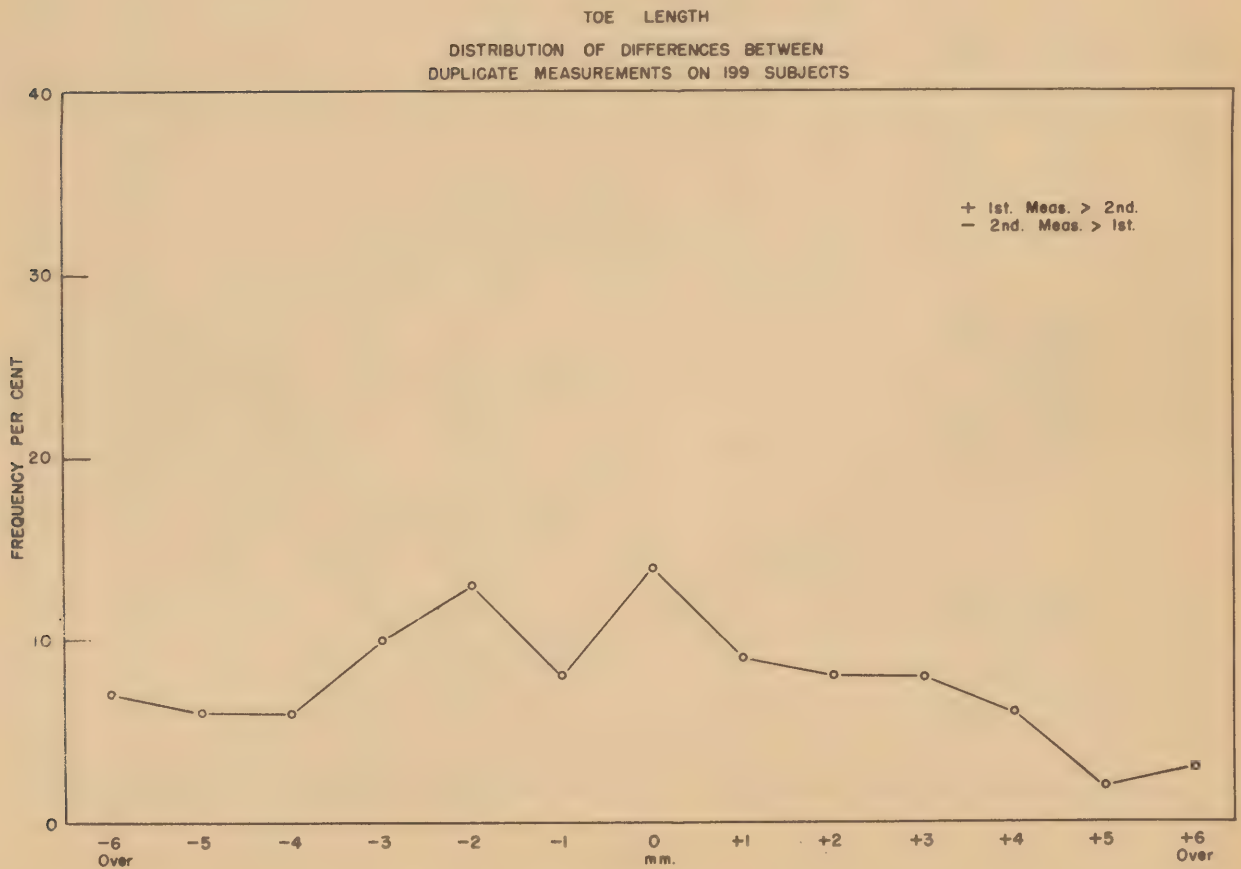


Figure 44



TABLE 18  
CORRELATION BETWEEN TOE LENGTH AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		TOE LENGTH											TOTAL	
		mm.	52- Less	53-56	57-60	61-64	65-68	69-72	73-76	77-80	81-84	85-88		89- Over
		in.	2 1/16 & Less	2 1/16 3 3/16	2 4/16 2 6/16	2 6/16 2 8/16	2 9/16 2 11/16	2 12/16 2 13/16	2 14/16 3"	3 1/16 3 2/16	3 3/16 3 5/16	3 6/16 3 7/16		3 8/16 & Over
mm.	in.													
84-89	3 5/16 - 3 8/16..													
90-95	3 9/16 - 3 12/16.			1	1									2
96-101	3 13/16 - 4 .....		2	1										3
102-107	4 - 4 3/16.....				1									1
108-113	4 4/16 - 4 7/16..													
114-119	4 8/16 - 4 11/16.													
120-125	4 12/16 - 4 15/16													
TOTAL.....			2	2	2									6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16 - 3 8/16..				3	2	1							6
90-95	3 9/16 - 3 12/16.				1	9	16	1						27
96-101	3 13/16 - 4 .....	2	4	8	20	8	1	1						44
102-107	4 - 4 3/16.....		1	2	4	22								9
108-113	4 4/16 - 4 7/16..													
114-119	4 8/16 - 4 11/16.													
120-125	4 12/16 - 4 15/16													
TOTAL.....		2	5	14	35	27	2	1						86

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16 - 3 8/16..				1	1								2
90-95	3 9/16 - 3 12/16.		1	9	29	30	14	1				1		85
96-101	3 13/16 - 4 .....		1	27	100	130	63	3	1	1				326
102-107	4 - 4 3/16.....		1	9	35	65	13	3	1					127
108-113	4 4/16 - 4 7/16..			5	2	2		1						10
114-119	4 8/16 - 4 11/16.				1	1	1							3
120-125	4 12/16 - 4 15/16													
TOTAL.....			3	50	168	229	91	8	2	1		1		553

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16 - 3 8/16..						1							1
90-95	3 9/16 - 3 12/16.			1	6	24	22	10	1					64
96-101	3 13/16 - 4 .....		1	7	87	255	234	73	5					662
102-107	4 - 4 3/16.....			15	81	219	195	42	4					556
108-113	4 4/16 - 4 7/16..			3	16	26	30	7						82
114-119	4 8/16 - 4 11/16.				1	2	1	1						5
120-125	4 12/16 - 4 15/16													
TOTAL .....			1	26	191	526	483	133	10					1370

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16 - 3 8/16..													
90-95	3 9/16 - 3 12/16.				1	10	6	5	2					24
96-101	3 13/16 - 4 .....			5	28	99	185	120	30	1	2			470
102-107	4 - 4 3/16.....			2	45	242	392	249	61	9	1			1001
108-113	4 4/16 - 4 7/16..	1		2	17	75	115	55	18	3				286
114-119	4 8/16 - 4 11/16.				1	7	8	6						22
120-125	4 12/16 - 4 15/16													
TOTAL.....		1		9	92	433	706	435	111	13	3			1803

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.) (Contd.)

DIAGONAL BREADTH		TOP LENGTH											TOTAL		
		mm.	52- Less	53-56	57-60	61-64	65-68	69-72	73-76	77-80	81-84	85-88		89- Over	
		in.	2 1/16 & Less	2 1/16	2 4/16	2 6/16	2 9/16	2 12/16	2 14/16	3 1/16	3 3/16	3 6/16		3 8/16 & Over	
mm.	in.														
84-89	3 5/16 - 3 8/16..														
90-95	3 9/16 - 3 12/16.							5	1	2				8	
96-101	3 13/16 - 4.....					1	17	58	71	28	1			176	
102-107	4 - 4 3/16.....					11	47	196	251	97	15			617	
108-113	4 4/16 - 4 7/16..					1	10	37	113	126	47	10	2	1	346
114-119	4 8/16 - 4 11/16.					1		7	15	17	5	1			46
120-125	4 12/16 - 4 15/16							2		2					4
TOTAL.....						2	22	110	387	468	179	27	2	1	1198

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16 - 3 8/16..													
90-95	3 9/16 - 3 12/16.								1					2
96-101	3 13/16 - 4.....							4	5	9	3	1		21
102-107	4 - 4 3/16.....						4	18	63	52	16	2	1	156
108-113	4 4/16 - 4 7/16..				2	8	30	49	60	22	7			178
114-119	4 8/16 - 4 11/16.					1	11	27	12	7				58
120-125	4 12/16 - 4 15/16					2	2			1	1			6
TOTAL.....					2	15	65	145	134	49	10	1		421

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16 - 3 8/16..													
90-95	3 9/16 - 3 12/16.													
96-101	3 13/16 - 4.....									1				1
102-107	4 - 4 3/16.....							4	7		4	2	2	19
108-113	4 4/16 - 4 7/16..							2	12	14	7	1	2	38
114-119	4 8/16 - 4 11/16.							2	7	679	8	6	1	24
120-125	4 12/16 - 4 15/16								2	2	2			6
TOTAL.....							4	25	32	19	4	4		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16 - 3 8/16..													
90-95	3 9/16 - 3 12/16.													
96-101	3 13/16 - 4.....													
102-107	4 4 3/16.....								1	2				3
108-113	4 4/16 - 4 7/16..											1		1
114-119	4 8/16 - 4 11/16.								1		2	3	1	7
120-125	4 12/16 - 4 15/16										1			1
TOTAL.....								2	2	3	4	1		12

# BREADTH OF 3 FORWARD TOES

GENERAL - This dimension was measured from a photograph of the sole as illustrated (Fig. 45). 98% of the white population is included within a range of 13/16 in. The Negro measurements tend to be smaller than those of the white subjects (Fig. 46, Table 19).



CORRELATIONS - The breadth of the three forward toes correlates poorly, if at all, with foot breadth and with foot length. There is a pronounced scatter of the measurements, such that a given foot length and/or breadth may be associated with a wide variety of toe breadths (Table 20).

DUPLICATE MEASUREMENTS - The algebraic mean of the difference between duplicate measurements was found to be -0.3 mm., and the absolute mean difference without regard to sign was 1.3 mm. The range of differences is shown in Fig. 47.

Figure 45  
Breadth of 3 Forward Toes

TABLE 19  
BREADTH OF 3 FORWARD TOES

No. Subjects	WHITE 5545		NEGRO 1194	
	mm.	in.	mm.	in.
Mean .....	69.7	2 12/16	67.0	2 10/16
100% range ....	52-89	2 1/16 - 3 8/16	52-83	2 1/16 - 3 4/16
98% .....	60-81	2 6/16 - 3 3/16	56-77	2 3/16 - 3 1/16
95% .....	61-78	2 6/16 - 3 1/16	58-75	2 5/16 - 2 15/16



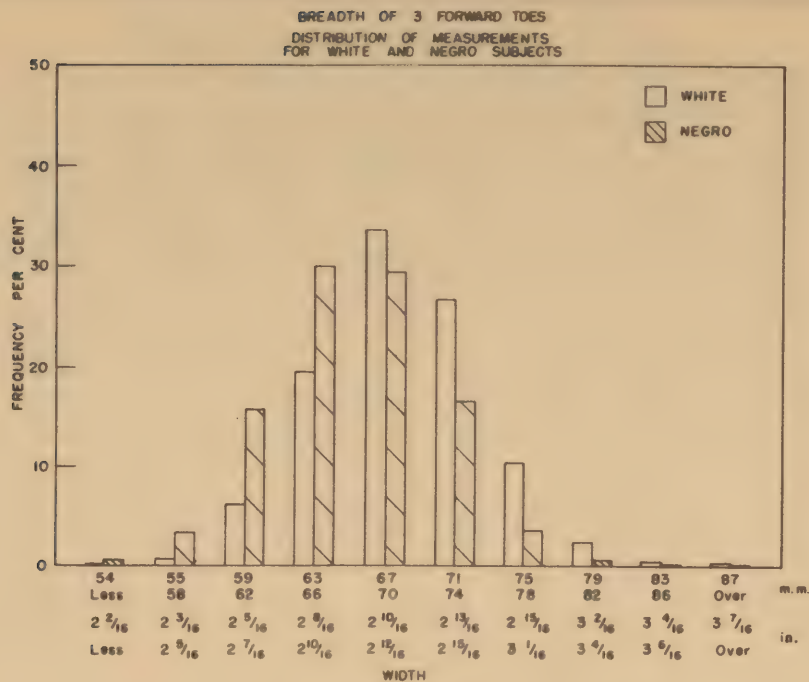


Figure 46

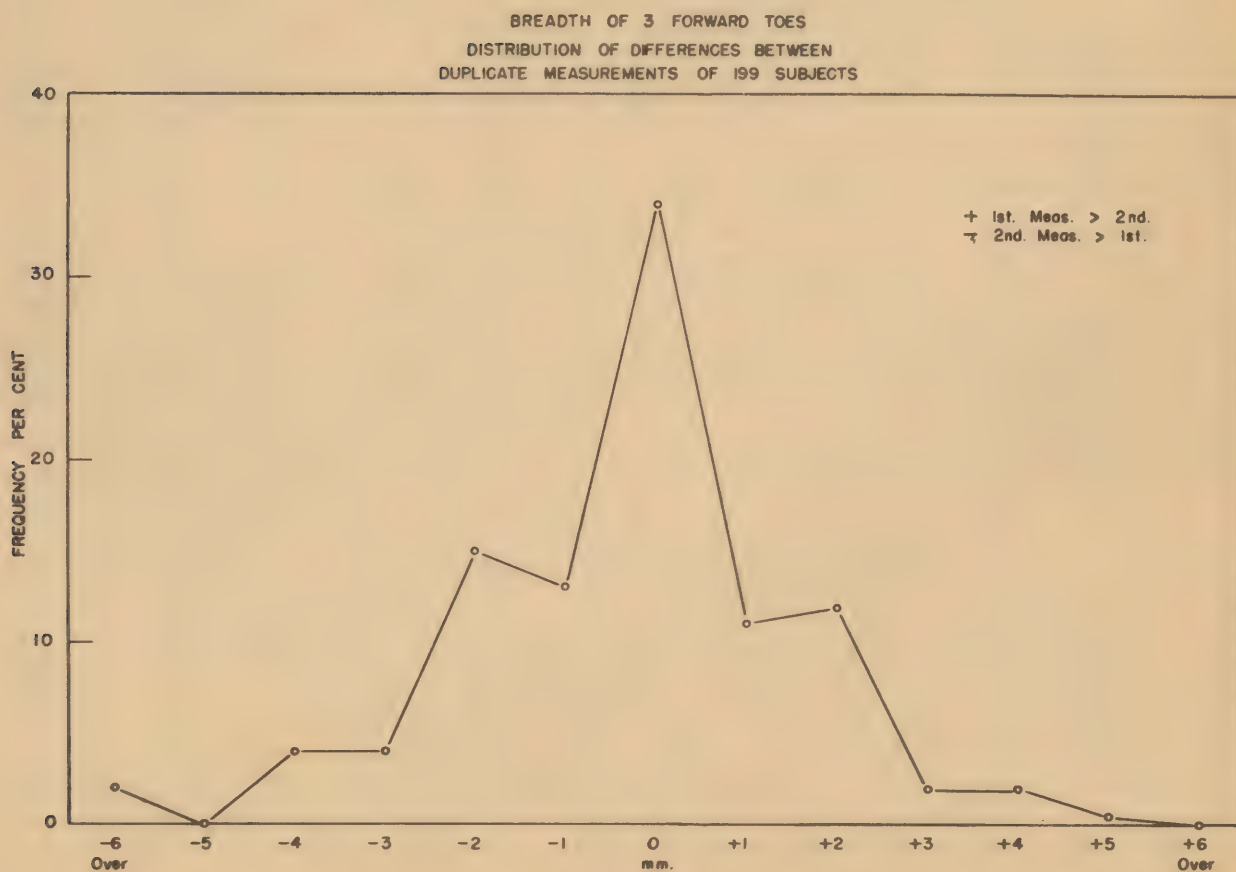


Figure 47

TABLE 20  
CORRELATION BETWEEN BREADTH OF THREE FORWARD TOES  
AND LENGTH AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		BREADTH OF THREE FORWARD TOES										TOTAL	
		mm.	54- Less	55-58	59-62	63-66	67-70	71-74	75-78	79-82	83-86		87- Over
		in.	2 2/16 & Less	2 3/16- 2 5/16	2 5/16- 2 7/16	2 8/16- 2 10/16	2 10/16- 2 12/16	2 13/16- 2 15/16	2 15/16- 3 1/16	3 2/16- 3 4/16	3 4/16- 3 6/16		3 7/16 & Over
mm.	in.												
84-89	3 5/16-3 8/16..												
90-95	3 9/16-3 12/16..				1	1						2	
96-101	3 13/16-4".....			1	1	1						3	
102-107	4"-4 3/16.....				1							1	
108-113	4 4/16-4 7/16..												
114-119	4 8/16-4 11/16..												
120-125	4 12/16-4 15/16..												
TOTAL.....				1	3	2						6	

LENGTH GROUP 235 to 244 mm. (9 4/16 in to 9 10/16 in)

84-89	3 5/16-3 8/16..	1	1	4									6
90-95	3 9/16-3 12/16..		1	1	10	14	1						27
96-101	3 13/16-4".....			14	16	9	4	1					44
102-107	4"-4 3/16.....				3	3	3						9
108-113	4 4/16-4 7/16..												.....
114-119	4 8/16-4 11/16..												.....
120-125	4 12/16-4 15/16..												.....
TOTAL.....		1	2	19	29	26	8	1					86

GROUP LENGTH 245 to 254 mm (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16..				1	1							2
90-95	3 9/16-3 12/16..	2	3	20	27	27	4						83
96-101	3 13/16-4".....		2	35	122	118	41	5	1				324
102-107	4"-4 3/16.....	1	2	8	27	46	32	11					127
108-113	4 4/16-4 7/16..			1	1	4	1	4					11
114-119	4 8/16-4 11/16..				1	1	1						3
120-125	4 12/16-4 15/16..												.....
TOTAL.....		3	7	64	179	197	79	20	1				550

LENGTH GROUP 255 to 264 mm (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16..				1								1
90-95	3 9/16-3 12/16..		2	14	28	19	3						66
96-101	3 13/16-4".....		8	72	210	261	99	12				2	664
102-107	4"-4 3/16.....		1	24	112	202	163	47	7	1			557
108-113	4 4/16-4 7/16..			4	9	22	31	13	3	1			83
114-119	4 8/16-4 11/16..				1		2		2				5
120-125	4 12/16-4 15/16..												.....
TOTAL.....			11	114	361	504	298	72	12	2	2		1376

LENGTH GROUP 265 to 274 mm (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16..												.....
90-95	3 9/16-3 12/16..		1	3	11	6	3						24
96-101	3 13/16-4".....		3	50	119	192	83	23	2		1		473
102-107	4"-4 3/16.....		6	29	168	353	324	106	11		2		999
108-113	4 4/16-4 7/16..			4	24	84	111	45	13	2	1		284
114-119	4 8/16-4 11/16..			2		5	4	6	3	2			22
120-125	4 12/16-4 15/16..												.....
TOTAL.....			10	88	322	640	525	180	29	4	4		1802

LENGTH GROUP 275 to 284 mm (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		BREADTH OF THREE FORWARD TOES										TOTAL	
		mm.	54- Less	55-58	59-62	63-66	67-70	71-74	75-78	79-82	83-86		87- Over
		in.	2 2/16 & Less	2 3/16- 2 5/16	2 5/16- 2 7/16	2 8/16- 2 10/16	2 10/16- 2 12/16	2 13/16- 2 15/16	2 15/16- 3 1/16	3 2/16- 3 4/16	3 4/16- 3 6/16		3 7/16 & Over
84-89	3 5/16-3 8/16..												
90-95	3 9/16-3 12/16..		1	1	4	2						8	
96-101	3 13/16-4".....		3	13	39	59	46	13	4			117	
102-107	4"-4 3/16.....		2	23	80	202	210	78	18	3		616	
108-113	4 4/16-4 7/16..			5	26	91	122	73	23	5		345	
114-119	4 8/16-4 11/16..			1		9	14	14	6	2		46	
120-125	4 12/16-4 15/16					1		2	1			4	
TOTAL.....			6	43	149	364	392	180	52	10		1196	

LENGTH GROUP 285 to 294 mm (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..												
90-95	3 9/16-3 12/16..						1	1					2
96-101	3 13/16-4".....			1	1	4	7	8					21
102-107	4"-4 3/16.....			1	3	21	57	48	20	6		1	157
108-113	4 4/16-4 7/16..			1	2	9	35	70	44	14	4		179
114-119	4 8/16-4 11/16..				1	1	8	12	20	8	4	3	57
120-125	4 12/16-4 15/16						1	1	3		1		6
TOTAL.....				3	7	35	109	140	87	28	9	4	422

LENGTH GROUP 295 to 304 mm (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16..												
90-95	3 9/16-3 12/16..												
96-101	3 13/16-4".....							1					1
102-107	4"-4 3/16.....					3	9	4	3				19
108-113	4 4/16-4 7/16..					1	5	14	14	4			38
114-119	4 8/16-4 11/16..					1	1	6	8	7	1		24
120-125	4 12/16-4 15/16							4	1	1			6
TOTAL.....						5	15	29	26	12	1		88

LENGTH GROUP 305 to 314 mm (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..												
90-95	3 9/16-3 12/16..												
96-101	3 13/16-4".....												
102-107	4"-4 3/16.....						2		1				3
108-113	4 4/16-4 7/16..						1	1					2
114-119	4 8/16-4 11/16..							1	3	2	1		7
120-125	4 12/16-4 15/16								1				1
TOTAL.....							3	2	5	2	1		13



# TOE HEIGHT

GENERAL - This dimension was measured as indicated in the accompanying photograph (Fig. 48). The caliper arm was moved over the dorsal surface of the toes until the highest surface was encountered; this height was then recorded. 98% of the white population is included within a range of 7/16 in.



Figure 48 - Toe Height

The toe height which will accommodate 99% of white men is 1 5/16 in. (Fig. 49, Table 21). This dimension provides for a fairly large number of individuals with hammer, clawed or otherwise elevated toes. The frequency of these anatomical peculiarities is noted in App. 3, wherein the clinical description of the subjects is reviewed. Among the white population the great toe is the highest in approximately 50% of the cases, whereas among the Negro population the second toe is by far the most frequently prominent. Both whites and Negroes are characterized by greatest prominence of the fifth toe in almost 10% of the cases (Fig. 50).

The Negro measurements tend to be larger than those of the white subjects (Fig. 49, Table 21.).

CORRELATIONS - Toe height correlates poorly, if at all, with foot length and with foot breadth. There is a pronounced scatter of the measurements, such that a given foot length and/or breadth may be associated with a wide variety of toe heights (Table 22).

TABLE 21  
TOE HEIGHT

No. Subjects	WHITE 5574		NEGRO 1200	
	mm.	in.	mm.	in.
Mean.....	27.4	1 1/16	28.3	1 2/16
100% range.....	20-48	13/16 - 1 14/16	21-40	13/16 - 1 9/16
98% range.....	22-34	14/16 - 1 5/16	23-35	15/16 - 1 6/16
95% "	23-32	15/16 - 1 4/16	24-33	15/16 - 1 5/16

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be -0.3 mm., and the absolute mean difference without regard to sign was 1.3 mm. The range of differences is shown in Fig. 51.

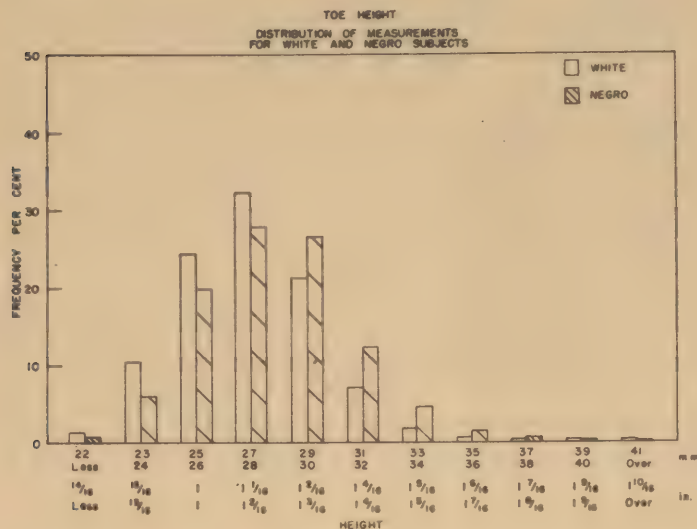


Figure 49

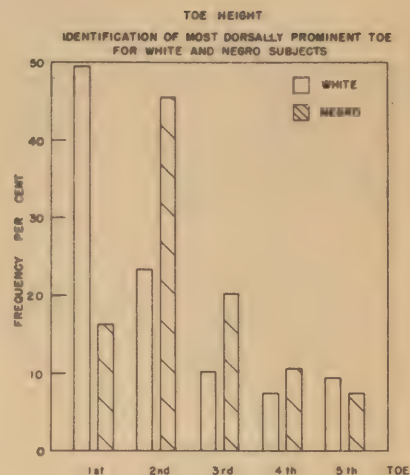


Figure 50

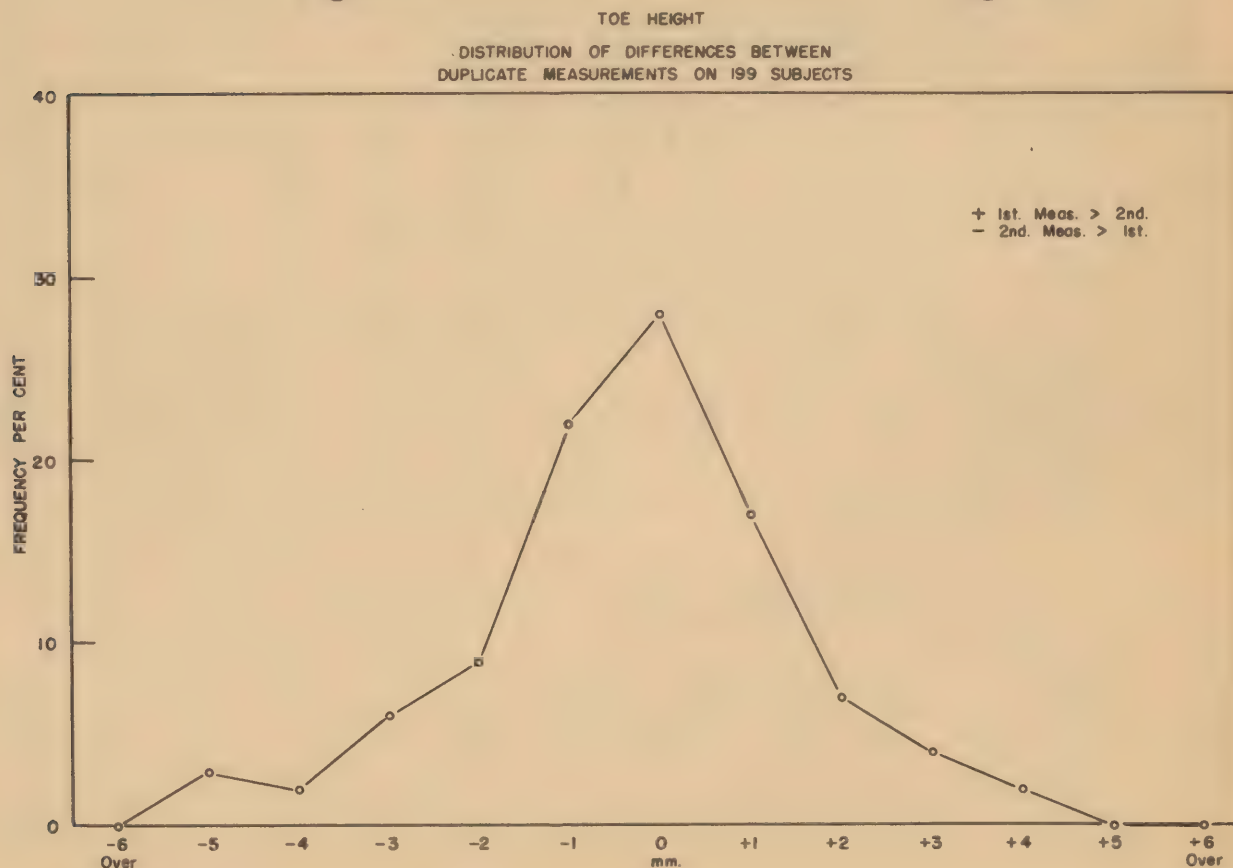


Figure 51

TABLE 22  
CORRELATION BETWEEN TOE HEIGHT AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		TOE HEIGHT										T O T A L	
		mm. 22 & Less	23-24	25-26	27-28	29-30	31-32	33-34	35-36	37-38	39-40		41 & Over
		in. 14/16 & Less	15/16	1" - 1"	1 1/16-1 2/16	1 2/16-1 3/16	1 4/16-1 5/16	1 5/16-1 6/16	1 6/16-1 7/16	1 7/16-1 8/16	1 8/16-1 9/16		1 9/16-1 10/16 Over
mm.	in.												
84-89	3 5/16-3 8/16..												
90-95	3 9/16-3 12/16..		1			1							2
96-101	3 13/16-4.....		1		1	1							3
102-107	4-4 3/16.....					1							1
108-113	4 4/16-4 7/16..												
114-119	4 8/16-4 11/16..												
120-125	4 12/16-4 15/16..												
TOTAL.....			2		1	3							6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16..	1	2	3									6
90-95	3 9/16-3 12/16..		6	10	5	5	1						27
96-101	3 13/16-4.....	2	12	17	8	6							45
102-107	4-4 3/16.....		1	2	5	1							9
108-113	4 4/16-4 7/16..												
114-119	4 8/16-4 11/16..												
120-125	4 12/16-4 15/16..												
TOTAL.....		3	21	32	18	12	1						87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16..		2										2
90-95	3 9/16-3 12/16..	7	23	29	19	5	1						84
96-101	3 13/16-4.....	8	54	103	101	47	10	3					326
102-107	4-4 3/16.....	1	13	33	50	25	3	3					128
108-113	4 4/16-4 7/16..		1	3	3	3		1					11
114-119	4 8/16-4 11/16..				2	1							3
120-125	4 12/16-4 15/16..												
TOTAL.....		16	93	168	175	81	14	7					554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16..			1									1
90-95	3 9/16-3 12/16..	5	17	26	15	1		1			1		66
96-101	3 13/16-4.....	13	110	223	204	86	23	3	1	2			665
102-107	4-4 3/16.....	12	51	138	194	120	35	7	1	1			559
108-113	4 4/16-4 7/16..		3	17	27	29	5	1	1				83
114-119	4 8/16-4 11/16..			1		2	1	1					5
120-125	4 12/16-4 15/16..												
TOTAL.....		30	181	406	440	238	64	13	3	3	1		1379

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16..												
90-95	3 9/16-3 12/16..		6	11	5	2							24
96-101	3 13/16-4.....	9	78	148	153	70	11	1	3	1		1	475
102-107	4-4 3/16.....	4	87	232	361	244	61	10	4	1	1		1005
108-113	4 4/16-4 7/16..	2	13	58	81	81	31	9	4	5			284
114-119	4 8/16-4 11/16..		3	5	4	5	1	4					22
120-125	4 12/16-4 15/16..												
TOTAL.....		15	187	454	604	402	104	24	11	7	1	1	1810



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREATH		TOE HEIGHT											T O T A L
		mm. 22 & Less	23-24	25-26	27-28	29-30	31-32	33-34	35-36	37-38	39-40	41 & Over	
		in. 14/16 & Less	15/16	1" - 1"	1 1/16 - 1 2/16	1 2/16 - 1 3/16	1 4/16 - 1 5/16	1 5/16 - 1 6/16	1 6/16 - 1 7/16	1 7/16 - 1 8/16	1 8/16 - 1 9/16	1 9/16 - 1 10/16 Over	
84-89	3 5/16-3 8/16..				3	2							8
90-95	3 9/16-3 12/16..	1	2		3	2							178
96-101	3 13/16-4.....	3	23	59	55	25	9	2	1			1	619
102-107	4-4 3/16.....	7	52	127	223	135	57	8	4	1	1	4	347
108-113	4 4/16-4 7/16..	2	12	49	105	119	38	14	5	2	1		46
114-119	4 8/16-4 11/16..			4	11	11	11	7	1		1		4
120-125	4 12/16-4 15/16	1	2		1								
TOTAL.....		14	91	239	398	292	115	31	11	3	3	5	1202

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..												2
90-95	3 9/16-3 12/16..				2								21
96-101	3 13/16-4.....	2	1	2	8	4	1	2			1		157
102-107	4-4 3/16.....	1	8	26	54	39	21	3	3	2			180
108-113	4 4/16-4 7/16..		3	19	47	60	30	13	3	2	2	1	58
114-119	4 8/16-4 11/16..			3	14	14	16	4	2	3	1	1	6
120-125	4 12/16-4 15/16				1	2	1	1					
TOTAL.....		3	12	50	126	119	69	23	8	7	4	3	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16..												1
90-95	3 9/16-3 12/16..												19
96-101	3 13/16-4.....				5	8	2	1		1	1		38
102-107	4-4 3/16.....			1	12	11	8	3		1			24
108-113	4 4/16-4 7/16..			3	5	6	10			2			6
114-119	4 8/16-4 11/16..			1	2	1	2			1			
120-125	4 12/16-4 15/16												
TOTAL.....				5	24	26	23	4		5	1		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..												3
90-95	3 9/16-3 12/16..												2
96-101	3 13/16-4.....												7
102-107	4-4 3/16.....					3							1
108-113	4 4/16-4 7/16..				1		1						
114-119	4 8/16-4 11/16..			1	1	2	3						
120-125	4 12/16-4 15/16						1						
TOTAL.....				1	2	5	5						13

# HEIGHT OF GREAT TOE TIP

GENERAL - This dimension was measured as illustrated in the accompanying photograph (Fig. 52). The height of the toe tip from the ground was recorded with the subject standing erect, with his weight equally balanced on both feet, and maintaining natural foot posture without voluntary effort either to plantarflex or dorsiflex the toes. 98% of the white population is included within a range of  $3/16$  in. The toe tip height which will accommodate 99% of white men is  $1\ 2/16$  in. The Negro measurements very closely approximate those of the white subjects (Fig. 53, Table 23).



Figure 52. Height of Great Toe Tip

CORRELATIONS - The height of the great toe tip correlates poorly, if at all, with foot length and with foot breadth. There is a pronounced scatter of the measurements, such that a given foot length and/or breadth may be associated with a wide variety of great toe tip heights (Table 24).

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be  $-0.3$  mm., and the absolute mean difference without regard to sign was  $1.4$  mm. The range of difference is shown in Fig. 54.

TABLE 23

## HEIGHT OF GREAT TOE

No. Subjects	WHITE 5575		NEGRO 1200	
	mm.	in.	mm.	in.
Mean. . . . .	22.9	$15/16$	22.8	$15/16$
100% range . .	14-34	$9/16 - 1\ 5/16$	14-34	$9/16 - 1\ 5/16$
98% " . .	18-28	$11/16 - 1\ 2/16$	17-28	$11/16 - 1\ 2/16$
95% " . .	19-27	$12/16 - 1\ 1/16$	18-27	$11/16 - 1\ 1/16$

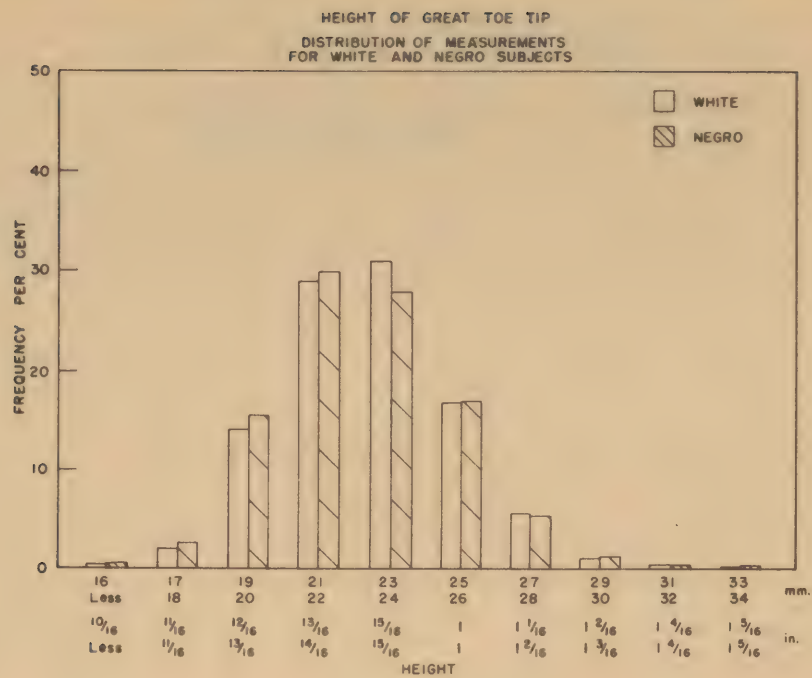


Figure 53

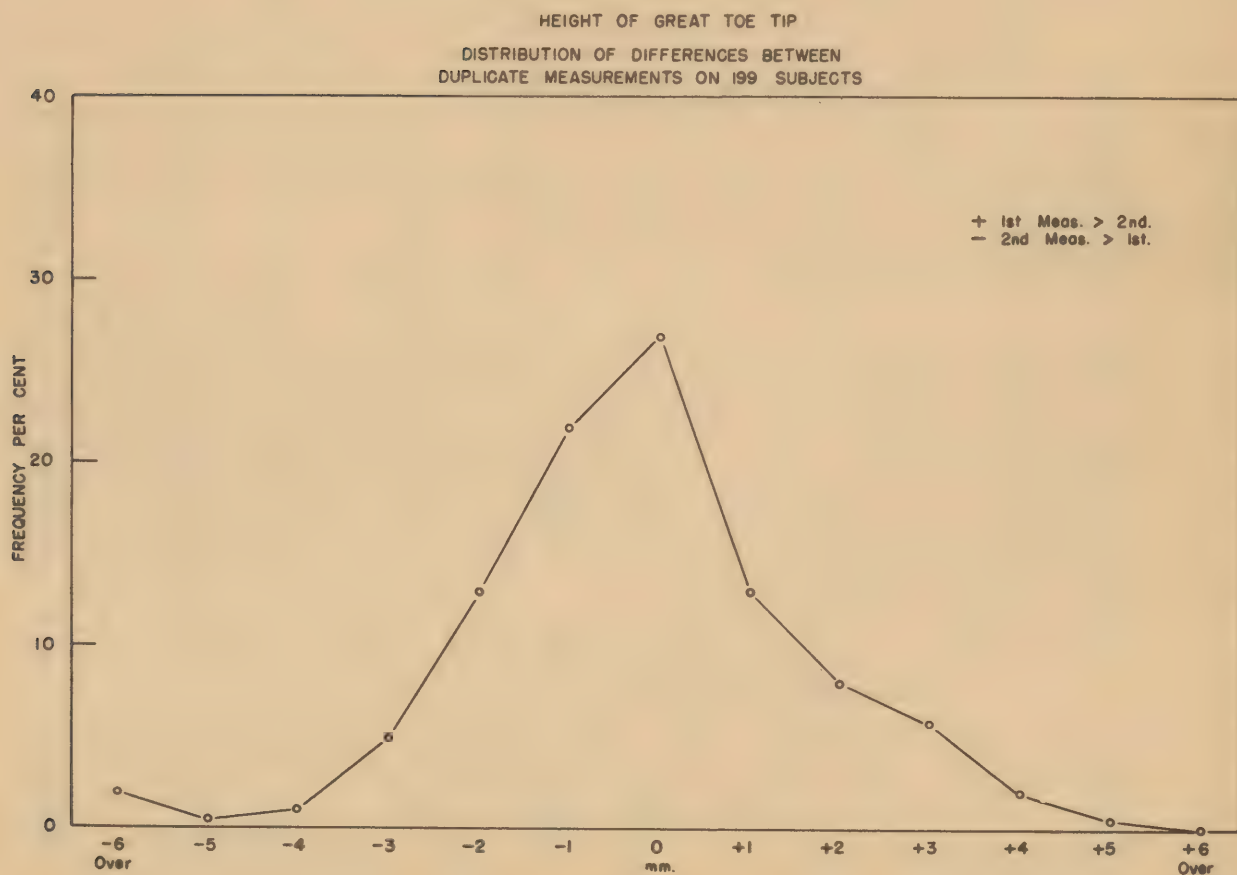


Figure 54



TABLE 24  
CORRELATION BETWEEN HEIGHT OF GREAT TOE TIP AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		HEIGHT OF GREAT TOE TIP										TOTAL
		mm. 16 & Less	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32	33-34	
		in. 10/16 & Less	11/16	12/16-13/16	13/16-14/16	15/16-15/16	1"-1"	1 1/16-1 2/16	1 2/16-1 3/16	1 4/16-1 4/16	1 5/16-1 5/16	
mm.	in.											
84-89	3 5/16-3 8/16..											
90-95	3 9/16-3 12/16..				2							2
96-101	3 13/16-4.....				2			1				3
102-107	4-4 3/16.....		1									1
108-113	4 4/16-4 7/16..											
114-119	4 8/16-4 11/16..											
120-125	4 12/16-4 15/16											
TOTAL.....			1		4			1				6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16..			3	2	1						6
90-95	3 9/16-3 12/16..		2	7	6	6	2	3	1			27
96-101	3 13/16-4.....	1	4	<u>16</u>	13	10	1					<u>45</u>
102-107	4-4 3/16.....				5	2	1		1			9
108-113	4 4/16-4 7/16..											
114-119	4 8/16-4 11/16..											
120-125	4 12/16-4 15/16											
TOTAL.....		1	6	26	<u>26</u>	19	4	3	2			87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16..				2							2
90-95	3 9/16-3 12/16..		5	19	<u>28</u>	19	13					84
96-101	3 13/16-4.....	3	21	71	<u>112</u>	69	38	10	2			<u>326</u>
102-107	4-4 3/16.....	1	1	24	<u>34</u>	<u>42</u>	21	4	1			<u>128</u>
108-113	4 4/16-4 7/16..			2	3	<u>3</u>	3					11
114-119	4 8/16-4 11/16..				3							3
120-125	4 12/16-4 15/16											
TOTAL.....		4	27	116	<u>182</u>	133	75	14	3			554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16..			1								1
90-95	3 9/16-3 12/16..	1	1	14	<u>23</u>	<u>14</u>	11	1		1		66
96-101	3 13/16-4.....	1	21	118	<u>208</u>	<u>209</u>	74	27	5	1	1	<u>665</u>
102-107	4-4 3/16.....	1	14	69	<u>170</u>	<u>202</u>	77	20	6			<u>560</u>
108-113	4 4/16-4 7/16..		1	11	20	<u>21</u>	21	8	1			83
114-119	4 8/16-4 11/16..				2	<u>1</u>	1		1			5
120-125	4 12/16-4 15/16											
TOTAL.....		3	37	213	423	<u>447</u>	184	56	13	2	2	1380

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16..											
90-95	3 9/16-3 12/16..		2	5	4	7	5	1				24
96-101	3 13/16-4.....	1	4	86	<u>142</u>	<u>133</u>	78	29	1	1		<u>475</u>
102-107	4-4 3/16.....	2	14	146	<u>272</u>	<u>336</u>	163	58	10	2	2	<u>1005</u>
108-113	4 4/16-4 7/16..		2	28	79	<u>98</u>	59	18	2			<u>286</u>
114-119	4 8/16-4 11/16..			1	5	<u>7</u>	6	3				22
120-125	4 12/16-4 15/16											
TOTAL.....		3	22	266	502	<u>581</u>	311	109	13	3	2	1812

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		HEIGHT OF GREAT TOE TIP									TOTAL	
		mm. 16 & Less	17-18	19-20	21-22	23-24	25-26	27-28	29-30	31-32		33-34
		in. 10/16 & Less	11/16-11/16	12/16-13/16	13/16-14/16	15/16-15/16	1"-1"	1 1/16-1 2/16	1 2/16-1 3/16	1 4/16-1 4/16		1 5/16-1 5/16
mm.	in.											
84-89	3 5/16-3 8/16..											8
90-95	3 9/16-3 12/16..		1	1	4	1	1					178
96-101	3 13/16-4.....	2	4	22	60	45	36	7		1	1	619
102-107	4-4 3/16.....	3	6	61	184	205	106	45	6	3		347
108-113	4 4/16-4 7/16..		7	31	74	119	77	32	6	1		46
114-119	4 8/16-4 11/16..			4	6	13	17	2	3	1		4
120-125	4 12/16-4 15/16			1			1	2				
TOTAL.....		5	18	120	328	383	236	88	15	6	1	1202

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..											2
90-95	3 9/16-3 12/16..					2						21
96-101	3 13/16-4.....			2	6	6	7					157
102-107	4-4 3/16.....			15	44	53	35	5	3	1	1	180
108-113	4 4/16-4 7/16..		1	17	54	53	38	13	4			58
114-119	4 8/16-4 11/16..			3	14	16	16	7	2			6
120-125	4 12/16-4 15/16			1		1	2	1		1		
TOTAL.....			1	38	118	131	98	26	9	2	1	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16..											1
90-95	3 9/16-3 12/16..											19
96-101	3 13/16-4.....						1					38
102-107	4-4 3/16.....			1	5	4	3	4	2			24
108-113	4 4/16-4 7/16..		1	2	11	8	9	5	1	1		6
114-119	4 8/16-4 11/16..			2	2	8	9	3				
120-125	4 12/16-4 15/16					1	4	1				
TOTAL.....			1	5	18	21	26	13	3	1		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..											3
90-95	3 9/16-3 12/16..											2
96-101	3 13/16-4.....											7
102-107	4-4 3/16.....					2		1				1
108-113	4 4/16-4 7/16..				1		1					
114-119	4 8/16-4 11/16..				1	1	1	2	2			
120-125	4 12/16-4 15/16			1								
TOTAL.....				1	2	3	2	3	2			13



Figure 55  
Anterior Curvature and  
Orientation of Toes

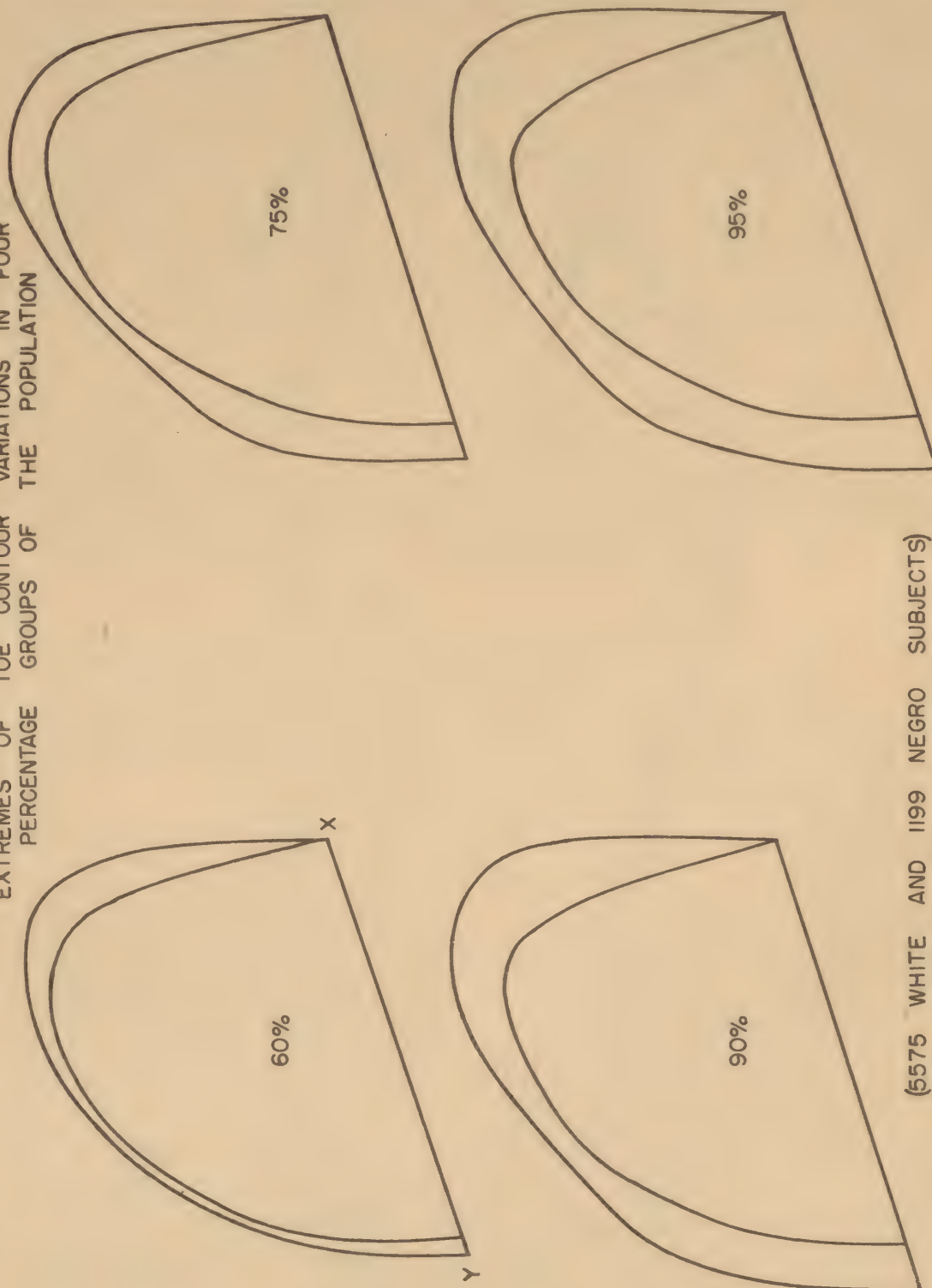
GENERAL - These dimensions were measured from a photograph of the sole as illustrated (Fig. 55). Transparent plastic templates were used to describe the anterior toe curvature, and simultaneously to determine the orientation of the toe region to the metatarsal heads. Four basic shapes were used, each varied by five possible angular variations (App. 2, Fig. 12 A). The contour limits of various proportions of the population are shown in Fig. 56, all with reference to a standard metatarsal baseline. The inner and outer curves do not represent differences in size but differences in orientation of the toes with reference to the metatarsal region. A composite single curve drawn on the outer margins will indicate the shape to accommodate 97.5% proportion of the population, with appropriate modification for size differences (Fig. 56A). This is applicable, however, only if the flare of the shoe is correct.

CORRELATIONS - The toe curves and their orientation correlate poorly, if at all, with foot length and breadth. There is a pronounced scatter of shapes such that a given foot length and/or breadth may be associated with a wide variety of toe curvatures (Table 25.).

DUPLICATE MEASUREMENTS - Duplicate photographs were examined for 199 subjects. 66% of these were interpreted as alike with regard to shape, and differing by angulation to the extent of 5° or less. 34% were interpreted as possessing, for the most part, minor differences in shape and angulation.



EXTREMES OF TOE CONTOUR VARIATIONS IN FOUR PERCENTAGE GROUPS OF THE POPULATION



(5575 WHITE AND 1199 NEGRO SUBJECTS)  
 X & Y REPRESENT PROMINENCES OF 1st & 5th  
 METATARSO - PHALANGEAL JOINTS RESPECTIVELY

Figure 56

MAXIMAL LIMITS OF TOE CONTOUR AND  
ORIENTATION FOR 97.5% OF THE POPULATION

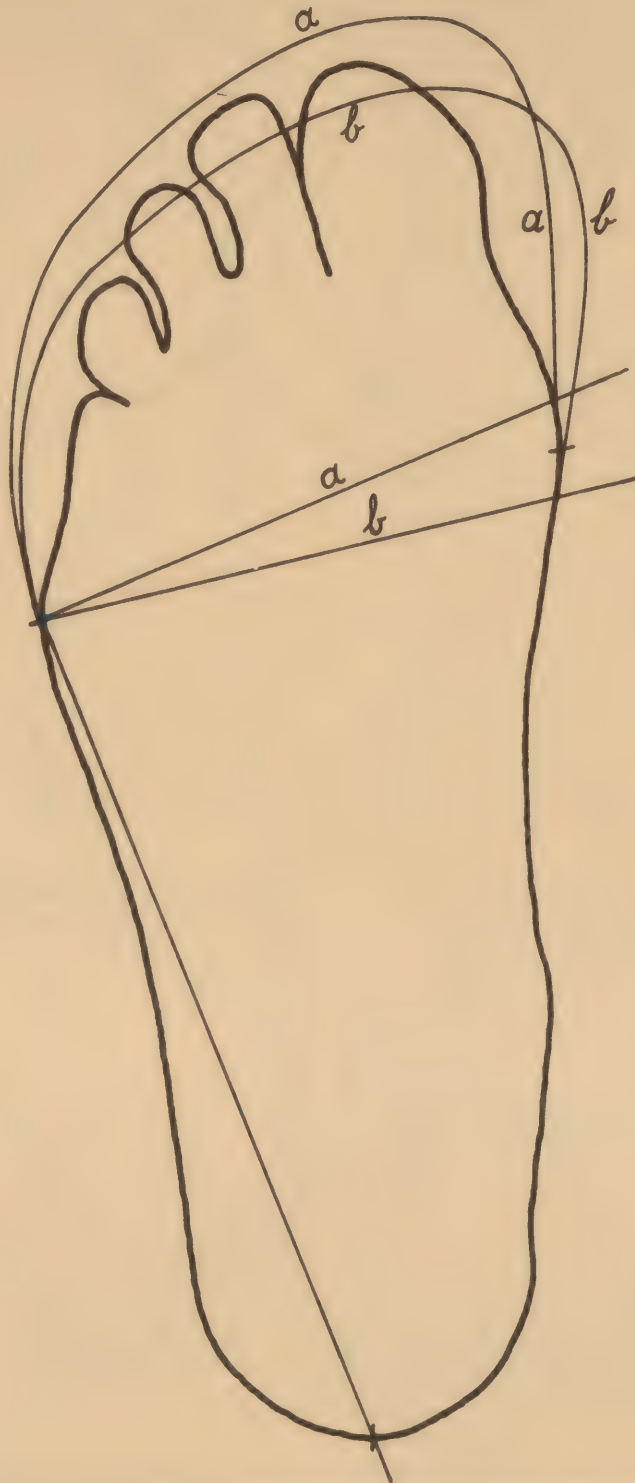


Figure 56 A

TABLE 25  
CORRELATION BETWEEN ANTERIOR CURVATURE AND ORIENTATION OF TOES AND  
LENGTH AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

		LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)																				TOTAL
DIAGONAL BREADTH		ANTERIOR CURVATURE AND ORIENTATION OF TOES																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
mm.	in.																					
84-89	3 5/16-3 8/16....																					
90-95	3 9/16-3 12/16....																	1				1
96-101	3 13/16-4....																	1		1		2
102-107	4 -4 3/16....																			1		1
108-113	4 4/16-4 7/16....																					
114-119	4 8/16-4 11/16....																					
120-125	4 12/16-4 15/16..																					
TOTAL.....																		2		2		4

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16....					2			3		1											6
90-95	3 9/16-3 12/16....							2	2	8	5	1		2	2		1		4			27
96-101	3 13/16-4....				2	5		2	4	<u>15</u>	8		3	1				1	3		1	<u>45</u>
102-107	4 -4 3/16....								1	2					1			3	2			9
108-113	4 4/16-4 7/16....																					
114-119	4 8/16-4 11/16....																					
120-125	4 12/16-4 15/16....																					
TOTAL.....					2	7		4	10	<u>25</u>	14	1	3	3	3		1	4	9		1	87

LENGTH GROUP 245 to 254 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16....							1		1												2
90-95	3 9/16-3 12/16....				4	12		1	7	<u>36</u>	13		2	2				1	3	1	1	83
96-101	3 13/16-4....				8	12		4	53	<u>105</u>	40		10	18	4	1	4	24	33	9	1	<u>326</u>
102-107	4 -4 3/16....				1			1	19	<u>25</u>	18	3	6	6	1	1	6	21	14	6		<u>128</u>
108-113	4 4/16-4 7/16....								3	2	1							2	2	1		11
114-119	4 8/16-4 11/16....										2									1		3
120-125	4 12/16-4 15/16....																					
TOTAL.....					13	24		7	82	<u>169</u>	74	3	18	26	5	2	10	48	52	18	2	553

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16....																	1				1
90-95	3 9/16-3 12/16....				3	19			4	<u>25</u>	11	1							2	1		66
96-101	3 13/16-4....		1	7	24	56	1	13	131	<u>225</u>	76	4	15	40	6		6	16	37	6	1	<u>665</u>
102-107	4 -4 3/16....			3	9	12	3	21	121	<u>136</u>	44	7	19	25	6	1	21	56	68	6	1	<u>559</u>
108-113	4 4/16-4 7/16....				2			4	14	<u>9</u>	6		2	3			5	24	10	3	1	83
114-119	4 8/16-4 11/16....									1	1		1					1		1		5
120-125	4 12/16-4 15/16....																					
TOTAL.....			1	10	38	87	4	38	270	<u>396</u>	138	12	37	68	12	1	32	98	117	17	3	1379

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16....																					
90-95	3 9/16-3 12/16....				3	10			3	4	3			1								24
96-101	3 13/16-4....			8	48	78		11	97	<u>141</u>	29	3	13	16	3		1	11	13	2		<u>474</u>
102-107	4 -4 3/16....			18	47	52	1	58	<u>289</u>	<u>218</u>	67	7	47	30			17	68	69	12	1	<u>1001</u>
108-113	4 4/16-4 7/16....			2	9	8	1	22	<u>61</u>	<u>44</u>	16	4	8	9		1	14	41	39	5	2	<u>286</u>
114-119	4 8/16-4 11/16....			1	1				6	8					1		2	4	2	1	1	22
120-125	4 12/16-4 15/16....																					
TOTAL.....				29	108	148	2	91	<u>456</u>	<u>410</u>	115	14	68	56	4	1	34	124	123	20	4	1807



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		ANTERIOR CURVATURE AND ORIENTATION OF TOES																				TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
mm.	in.																					
84-89	3 5/16-3 8/16....	.....	.....	.....	.....	5	.....	.....	1	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
90-95	3 9/16-3 12/16....	.....	.....	.....	1	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	178
96-101	3 13/16-4.....	.....	.....	9	32	39	1	8	35	36	6	1	2	4	.....	.....	.....	4	1	.....	.....	617
102-107	4-4 3/16.....	.....	3	23	69	62	1	33	166	108	37	9	26	26	.....	.....	5	16	28	3	2	345
108-113	4 4/16-4 7/16....	.....	.....	6	14	16	1	16	95	66	23	4	11	8	.....	.....	18	34	29	3	1	46
114-119	4 8/16-4 11/16....	.....	.....	.....	.....	.....	1	2	8	5	7	.....	.....	.....	.....	1	5	3	13	.....	1	4
120-125	4 12/16-4 15/16...	.....	.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	1	.....	1	.....	4
TOTAL.....		.....	3	38	115	122	4	59	306	217	74	14	39	38	.....	1	28	58	71	7	4	1198

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

mm.	in.																					
84-89	3 5/16-3 8/16....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16....	.....	.....	.....	1	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	2
96-101	3 13/16-4.....	.....	.....	5	6	3	.....	.....	1	3	.....	1	.....	.....	.....	.....	.....	.....	1	.....	.....	21
102-107	4-4 3/16.....	.....	4	10	30	18	1	6	39	21	6	1	5	6	.....	.....	.....	1	8	1	.....	157
108-113	4 4/16-4 7/16....	.....	1	12	20	14	1	19	35	29	8	3	1	3	1	.....	10	11	10	2	.....	180
114-119	4 8/16-4 11/16....	.....	.....	2	2	3	1	4	9	14	4	1	1	.....	.....	.....	3	7	6	1	.....	58
120-125	4 12/16-4 15/16...	.....	.....	.....	.....	.....	.....	.....	1	1	1	.....	.....	.....	.....	.....	1	.....	.....	1	.....	5
TOTAL.....		.....	5	29	59	38	3	29	85	68	20	5	8	9	1	.....	14	19	26	5	.....	423

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

mm.	in.																					
84-89	3 5/16-3 8/16....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
96-101	3 13/16-4.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
102-107	4-4 3/16.....	.....	.....	2	5	3	.....	2	3	1	1	.....	1	.....	.....	.....	.....	.....	1	.....	.....	19
108-113	4 4/16-4 7/16....	.....	.....	5	6	4	.....	1	10	3	.....	1	2	5	1	.....	.....	.....	.....	.....	.....	38
114-119	4 8/16-4 11/16....	.....	.....	1	2	1	.....	2	2	7	2	.....	.....	.....	.....	.....	4	2	1	.....	.....	24
120-125	4 12/16-4 15/16...	.....	.....	.....	.....	.....	.....	.....	3	1	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	6
TOTAL.....		.....	.....	8	13	8	.....	5	19	12	3	.....	2	2	5	1	4	2	4	.....	.....	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

mm.	in.																					
84-89	3 5/16-3 8/16....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
96-101	3 13/16-4.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
102-107	4-4 3/16.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
108-113	4 4/16-4 7/16....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	2
114-119	4 8/16-4 11/16....	.....	.....	.....	1	.....	.....	1	3	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
120-125	4 12/16-4 15/16...	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
TOTAL.....		.....	1	2	.....	1	1	2	3	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	12

## FOOT BREADTH (DIAGONAL)

GENERAL - This dimension was measured from a photograph of the sole as illustrated (Fig. 57). Any one measurement cannot strictly be compared with any other because of the fact that the angular relationship between the 1st and 5th metatarsal joints differs from individual to individual. This dimension was recorded, however, because it is similar to the one used in the shoe trade. 98% of the white population is included within a range of 14/16 in. The Negro measurements tend to be larger than those of the white subjects (Fig. 58, Table 26).

CORRELATIONS - The coefficient of correlation between length and breadth was found to be:  $r = .54 - .01$ . This relatively imperfect correlation raises the question whether it is advantageous for widths of shoes to increase with length, as is now the practice in shoe manufacture.

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be  $-0.1$  mm., and the absolute mean difference without regard to sign was  $1.5$  mm. The range of differences is shown as the continuous line in Fig. 59.

DIFFERENCES BETWEEN RIGHT AND LEFT FOOT - The mean left foot length was  $0.6$  mm. wider than the right foot. The distribution of the differences between the measurements of the right and left foot are shown by the broken line in Fig. 59, where they are compared with differences between duplicate measurements on the same foot.



Figure 57  
Foot Breadth (Diagonal)

TABLE 26  
FOOT BREADTH (DIAGONAL)

		WHITE		NEGRO	
		5567		1195	
		mm.	in.	mm.	in.
Mean. . . . .	103.3		4 1/16	105.4	4 2/16
100% range . .	84-124	3 5/16 - 4 14/16		87-132	3 7/16 - 5 3/16
98% range . .	92-115	3 10/16 - 4 8/16		94-117	3 11/16 - 4 10/16
95% range . .	94-113	3 11/16 - 4 7/16		96-115	3 13/16 - 4 8/16

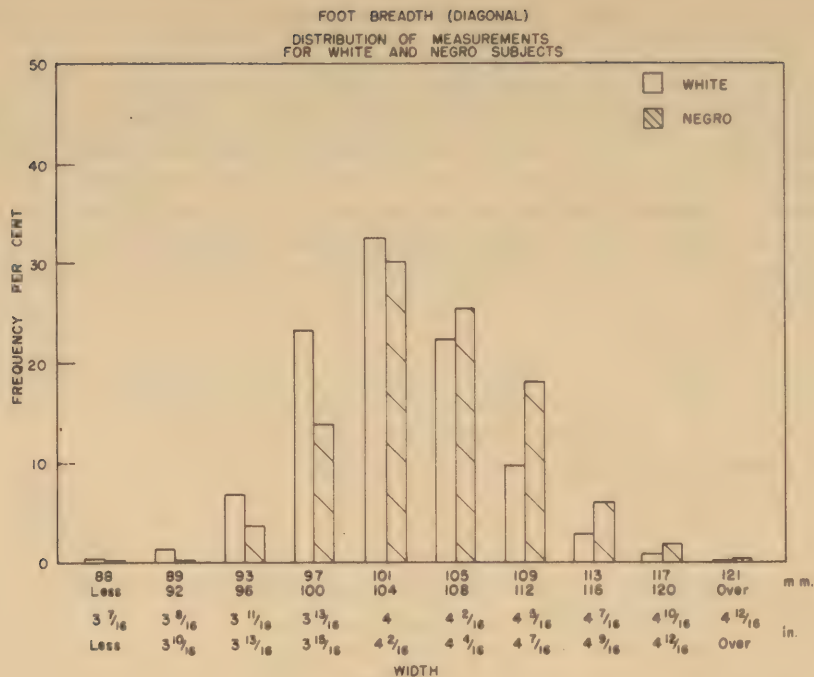


Figure 58

FOOT BREADTH (DIAGONAL)  
DISTRIBUTION OF DIFFERENCES BETWEEN  
DUPLICATE MEASUREMENTS ON 199 SUBJECTS  
COMPARED WITH  
DIFFERENCES BETWEEN RIGHT AND LEFT FOOT  
MEASUREMENTS ON 5568 SUBJECTS

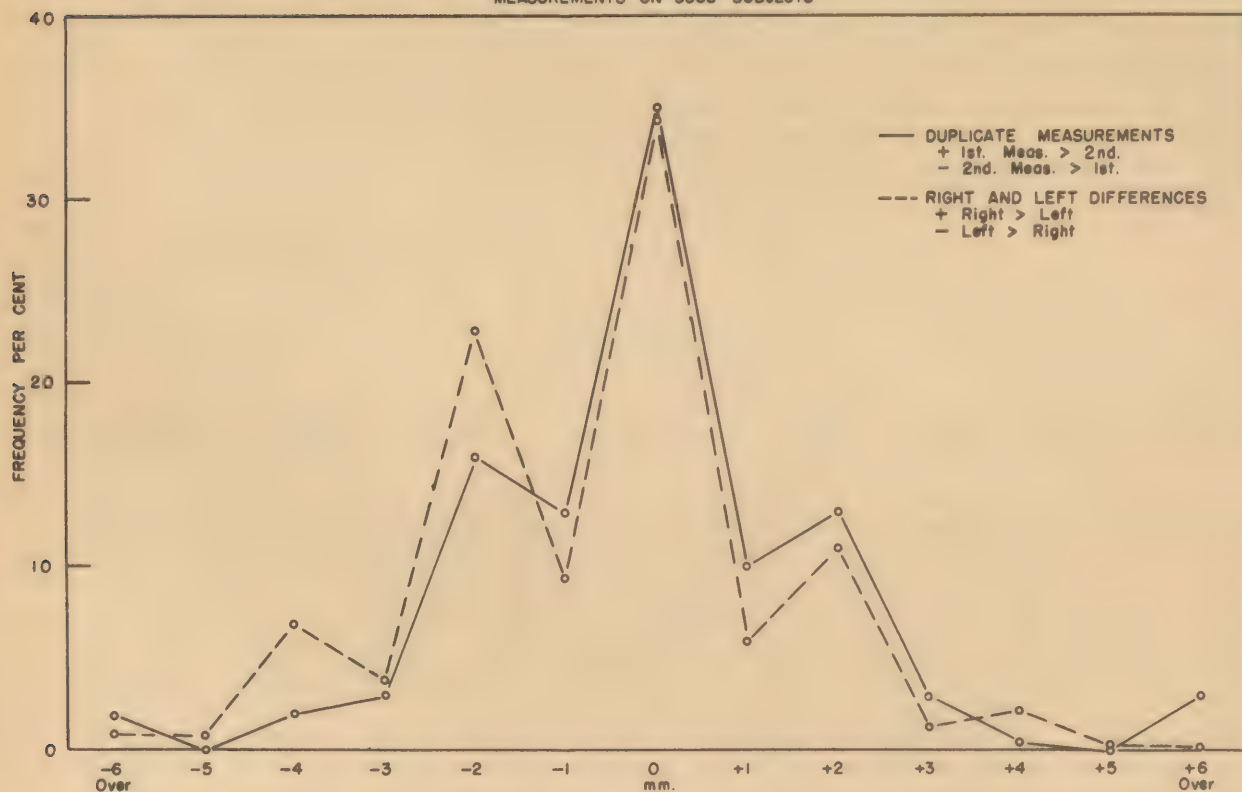


Figure 59



## FOOT BREADTH (HORIZONTAL)

GENERAL - This dimension was measured from a photograph of the sole as illustrated (Fig. 60). It represents the horizontal distance between the planes of the most medial and most lateral foot surfaces, parallel to the longitudinal axis ( $x \neq y$ ), and is independent of the angular relationship between the 1st and 5th metatarso-phalangeal prominences. 98% of the white population is included within a range of 15/16 in. The Negro measurements tend to be slightly larger than those of the white subjects (Fig. 61, Table 27).

CORRELATIONS - Correlations between this dimension and length and diagonal breadth measurements were not prepared since the horizontal breadth so closely approximates the diagonal breadth.

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be zero, and the absolute mean difference without regard to sign was 1.9 mm. The range of difference is shown in Fig. 62.

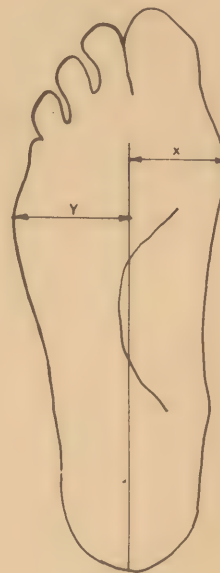


Figure 60  
Foot Breadth (Horizontal)

TABLE 27

### FOOT BREADTH (HORIZONTAL)

	WHITE 5561		NEGRO 1199	
	mm.	in.	mm.	in.
Mean . . . . .	98.0	3 14/16	99.2	3 14/16
100% range . .	80-116	3 2/16 - 4 9/16	80-122	3 2/16 - 4 13/16
98% range . .	86-110	3 6/16 - 4 5/16	88-111	3 7/16 - 4 6/16
95% range . .	88-107	3 7/16 - 4 3/16	90-109	3 9/16 - 4 5/16

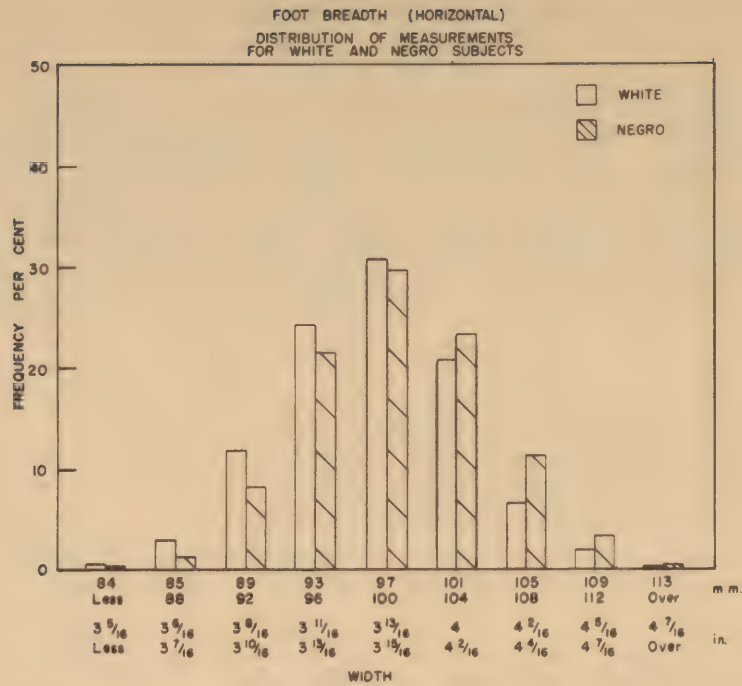


Figure 61

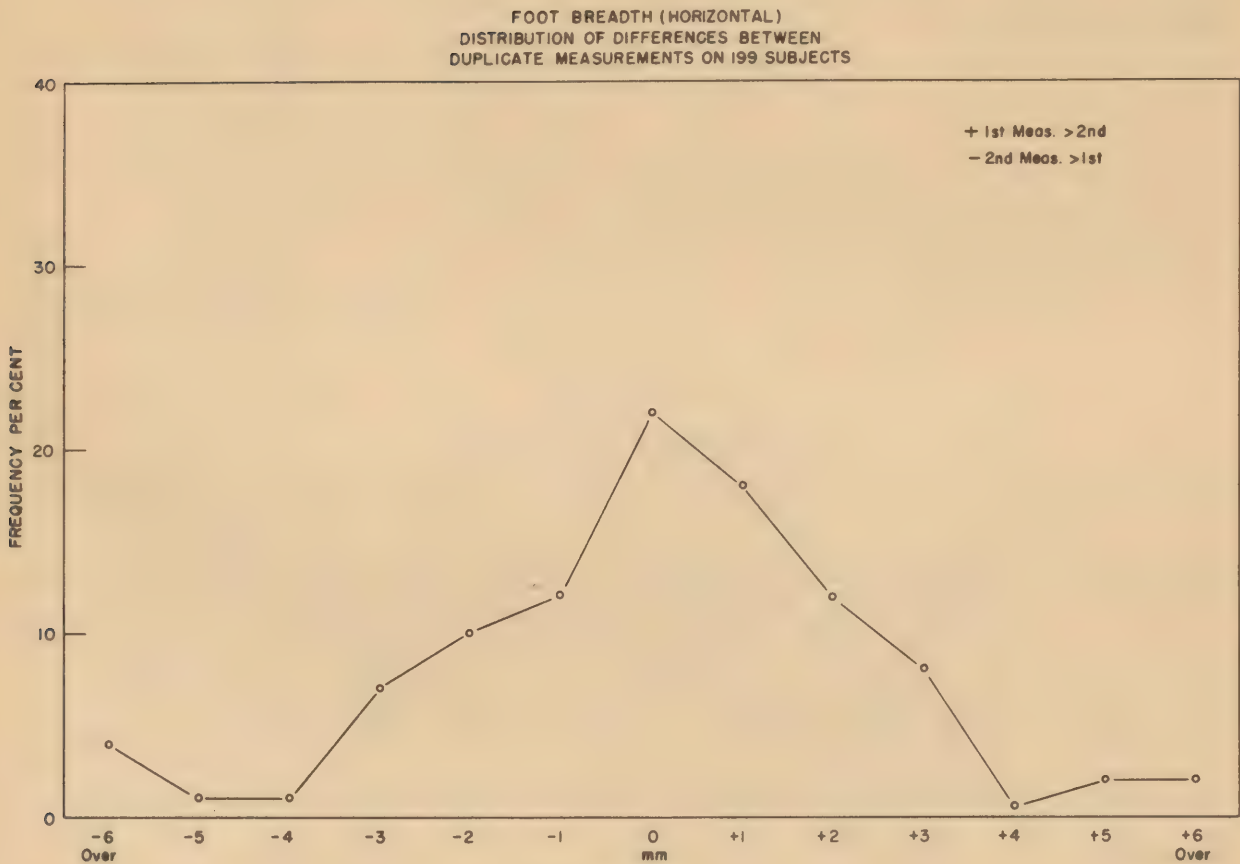


Figure 62

# FOOT FLARE

GENERAL - This dimension was measured from a photograph of the sole as illustrated (Fig. 63). A line bisecting the heel was extended forward to the metatarsal area and the ratio of the foot breadth medial to this line to the total foot breadth was computed. The ratio is, therefore, a measure of the deviation of the forepart of the foot with regard to the heel, and affords a useful index of the basic shape of the foot. It is independent of rotation at the ankle joint or above.

The range of the ratios of foot breadth medial to the longitudinal axis for 98% of the white population is from 20% to 48%. With reference to the practice in the shoe trade describing feet as "inflare", "outflare", and "straight draught", these data reveal that there are but few individuals with either "inflare" or "straight draught" characteristics, while the great majority are characterized by a greater or lesser degree of "outflare". A "straight draught" foot would be one with a ratio of approximately 50%; "outflare" would be less than 50% and "inflare" more. Negroes seem to have a slightly smaller tendency to extreme outflare than whites (Fig. 64, Table 28). Fig. 65 shows the range of these ratios for 95% of the population.

CORRELATIONS - The degree of foot flare correlates poorly, if at all, with foot length and breadth. There is a pronounced scatter of ratios such that a given foot length and/or breadth may be associated with a wide variety of flare characteristics (Table 29).

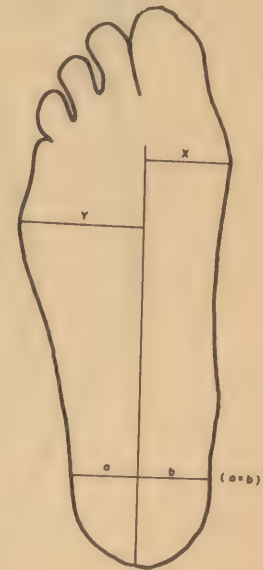


Figure 63  
Foot Flare  
 $\left( \frac{x}{x+y} \right)$

TABLE 28  
FOOT FLARE

No. Subjects	WHITE 5567	NEGRO 1198
	Percent	Percent
Mean.....	34.3	35.5
100% range.....	7-58	19-53
98% range.....	20-48	23-49
95% range.....	22-46	25-47





RANGE OF FOOT FLARE FOR 95%  
OF THE POPULATION

Figure 65

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be  $-0.6\%$ , and the absolute mean difference without regard to sign was  $5.1\%$ .  $56\%$  of the 199 duplicate measurements checked to five percent or less and the remaining  $44\%$  differed by six to twenty percentage points. The determination of this ratio is dependent upon whether the line defining the longitudinal axis of the foot is duplicated exactly. Since its direction is determined at the heel, and since the ratio is computed from measurements at the forepart of the foot, any slight difference in locating the longitudinal axis tends to be magnified by the ratio computation. The distribution of the differences is shown in Fig. 66.

INTERPRETATION - It is probable that these data should not be interpreted for description of the deviation of the forepart of the foot to any greater degree of precision than identification of three or four categories. Three categories would permit the classification of individuals as extreme outflare, moderate outflare, and minimum outflare, including in this last group the few cases of straight draught and inflare.

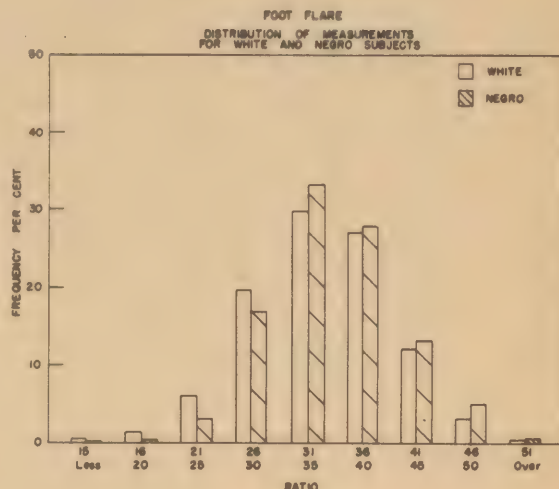


Figure 64

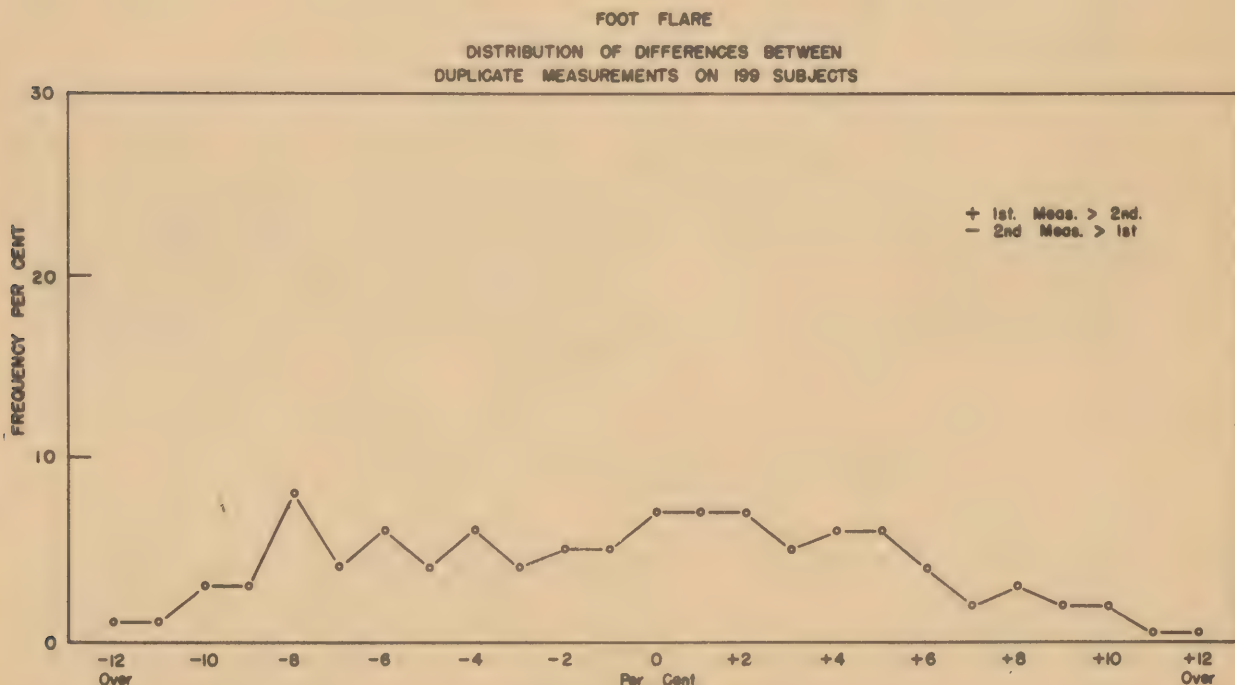


Figure 66

TABLE 29  
CORRELATION BETWEEN FOOT FLARE AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		FOOT FLARE									TOTAL
		Percent	15- Less	16-20	21-25	26-30	31-35	36-40	41-45	46-50	
mm.	in.										
84-89	3 5/16 - 3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16 - 3 12/16..	.....	.....	.....	.....	.....	1	.....	1	.....	2
96-101	3 13/16 - 4.....	.....	.....	.....	.....	2	1	.....	.....	.....	3
102-107	4 - 4 3/16.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1
108-113	4 4/16 - 4 7/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
114-119	4 8/16 - 4 11/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
120-125	4 12/16 - 4 15/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		.....	.....	.....	.....	2	2	1	1	.....	6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16 - 3 8/16..	.....	.....	.....	.....	2	3	1	.....	.....	.....	6
90-95	3 9/16 - 3 12/16..	.....	.....	.....	.....	3	4	13	5	2	.....	27
96-101	3 13/16 - 4.....	.....	.....	1	1	8	22	8	3	1	1	45
102-107	4 - 4 3/16.....	.....	.....	.....	.....	2	4	1	1	1	.....	9
108-113	4 4/16 - 4 7/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
114-119	4 8/16 - 4 11/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
120-125	4 12/16 - 4 15/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		.....	.....	1	1	15	33	23	9	4	1	87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16 - 3 8/16..	.....	.....	.....	.....	.....	.....	1	1	.....	.....	2
90-95	3 9/16 - 3 12/16..	.....	1	2	7	18	27	18	8	3	.....	84
96-101	3 13/16 - 4.....	.....	.....	8	16	61	95	86	41	14	5	326
102-107	4 - 4 3/16.....	.....	.....	1	2	19	45	31	20	7	3	128
108-113	4 4/16 - 4 7/16..	.....	.....	.....	.....	1	2	4	2	.....	.....	11
114-119	4 8/16 - 4 11/16..	.....	.....	.....	.....	.....	1	1	.....	.....	1	3
120-125	4 12/16 - 4 15/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		.....	1	11	25	99	170	141	72	26	9	554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16 - 3 8/16..	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1
90-95	3 9/16 - 3 12/16..	.....	.....	.....	4	14	22	17	6	2	1	66
96-101	3 13/16 - 4.....	.....	1	15	43	126	197	179	70	28	5	664
102-107	4 - 4 3/16.....	.....	1	4	24	112	157	170	73	16	3	560
108-113	4 4/16 - 4 7/16..	.....	.....	2	3	7	22	35	12	2	.....	83
114-119	4 8/16 - 4 11/16..	.....	.....	.....	.....	.....	1	3	1	.....	.....	5
120-125	4 12/16 - 4 15/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		.....	2	21	74	259	399	405	162	48	9	1379

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16 - 3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16 - 3 12/16..	.....	.....	1	5	5	6	5	2	.....	.....	24
96-101	3 13/16 - 4.....	.....	1	6	39	105	141	116	51	13	2	474
102-107	4 - 4 3/16.....	.....	2	11	58	191	307	269	128	34	4	1004
108-113	4 4/16 - 4 7/16..	.....	1	.....	14	52	89	81	44	4	1	286
114-119	4 8/16 - 4 11/16..	.....	.....	.....	1	3	7	2	2	.....	.....	22
120-125	4 12/16 - 4 15/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		.....	4	18	117	356	550	480	227	51	7	1810



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		FOOT FLARE									TOTAL	
		Percent	15-Less	16-20	21-25	26-30	31-35	36-40	41-45	46-50		51-Over
mm.	in.											
84-89	3 5/16 - 3 8/16..											
90-95	3 9/16 - 3 12/16..				2	3	2		1		8	
96-101	3 13/16 - 4.....		1	3	20	49	45	38	15	4	178	
102-107	4 - 4 3/16.....		1	8	44	135	187	169	62	13	619	
108-113	4 4/16 - 4 7/16..			4	24	69	94	97	44	14	347	
114-119	4 8/16 - 4 11/16..				1	3	13	16	12	1	46	
120-125	4 12/16 - 4 15/16..			1			2	1			4	
TOTAL.....			2	16	91	259	343	321	134	32	4	1202

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16 - 3 8/16..											
90-95	3 9/16 - 3 12/16..					1	1					2
96-101	3 13/16 - 4.....				3	3	9	5	1			21
102-107	4 - 4 3/16.....		1	4	5	42	43	39	13	8	2	157
108-113	4 4/16 - 4 7/16..			1	15	35	52	48	26	3		180
114-119	4 8/16 - 4 11/16..				1	6	17	15	13	6		58
120-125	4 12/16 - 4 15/16..				1		1	3		1		6
TOTAL.....			1	5	25	87	123	110	53	18	2	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16 - 3 8/16..											
90-95	3 9/16 - 3 12/16..											
96-101	3 13/16 - 4.....					1						1
102-107	4 - 4 3/16.....					7	5	5	1	1		19
108-113	4 4/16 - 4 7/16..			2	2	4	17	10	3			38
114-119	4 8/16 - 4 11/16..				3	5	8	5	3			24
120-125	4 12/16 - 4 15/16..					1	2	2	1			6
TOTAL.....				2	5	18	32	22	8	1		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16 - 3 8/16..											
90-95	3 9/16 - 3 12/16..											
96-101	3 13/16 - 4.....											
102-107	4 - 4 3/16.....						1	1	1			3
108-113	4 4/16 - 4 7/16..						2					2
114-119	4 8/16 - 4 11/16..				1	4		2				7
120-125	4 12/16 - 4 15/16..								1			1
TOTAL.....					1	4	3	3	2			13

## BALL GIRTH

GENERAL - This dimension was measured as illustrated in the accompanying photograph (Fig. 67). 98% of the white population is included within a range of  $2 \frac{2}{16}$  in. The Negro measurements tend to be larger than those of the white subjects. (Fig. 68, Table 30)

CORRELATIONS - Ball girth correlates moderately well with both length and breadth measurements. The relationship to foot breadth is to be expected since that dimension constitutes the diameter of the irregular ellipse of which ball girth is the circumference. The correlation to foot length is a reflection of the correlation between foot length and foot breadth. There is a pronounced scatter of the measurements, however, such that a given foot length and/or breadth may be associated with a wide variety of ball girths (Table 31). This is due to the fact that both ball height and outside ball height, which are altitudes of the ellipse, correlate poorly, if at all, with ball girth.



Figure 67  
Ball Girth

TABLE 30  
BALL GIRTH

DUPLICATE MEASUREMENTS - The algebraic mean of the difference between duplicate measurements was found to be  $-0.4$  mm, and the absolute mean difference without regard to sign was 2.2 mm. The range of differences is shown as the continuous line in Fig. 69.

No. Subjects	WHITE 5575		NEGRO 1200	
	mm.	in.	mm.	in.
Mean.....	251.8	9 $\frac{15}{16}$	253.5	10
100% range.....	209-299	8 $\frac{4}{16}$ - 11 $\frac{12}{16}$	212-307	8 $\frac{6}{16}$ - 12 $\frac{1}{16}$
98% range.....	226-280	8 $\frac{14}{16}$ - 11	227-283	8 $\frac{15}{16}$ - 11 $\frac{2}{16}$
95% range.....	230-275	9 $\frac{1}{16}$ - 10 $\frac{13}{16}$	230-278	9 $\frac{1}{16}$ - 10 $\frac{15}{16}$

DIFFERENCES BETWEEN RIGHT AND LEFT FOOT - The mean right foot girth was 0.15 mm. larger than the mean left foot girth. The distribution of the differences between the measurements of the right and left foot are shown by the broken line in Fig. 69, where they are compared with the differences between the duplicate measurements on the same foot.

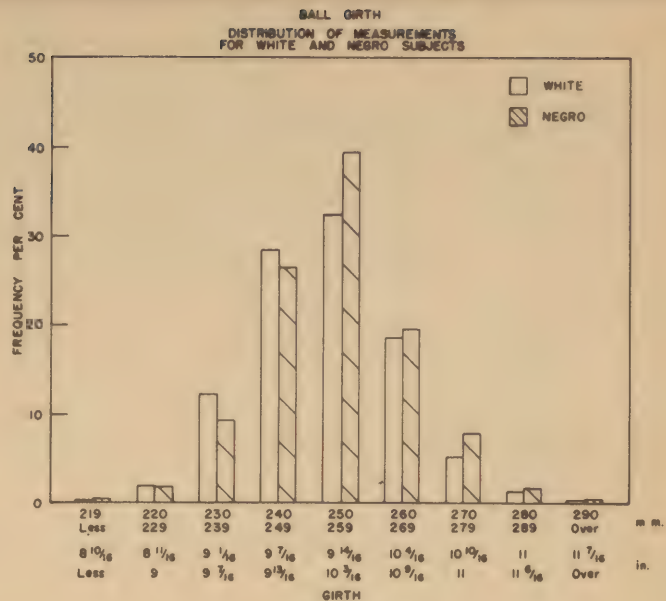


Figure 68

BALL GIRTH  
DISTRIBUTION OF DIFFERENCES BETWEEN  
DUPLICATE MEASUREMENTS ON 199 SUBJECTS  
COMPARED WITH  
DIFFERENCES BETWEEN RIGHT AND LEFT FOOT MEASUREMENTS  
ON 5571 SUBJECTS

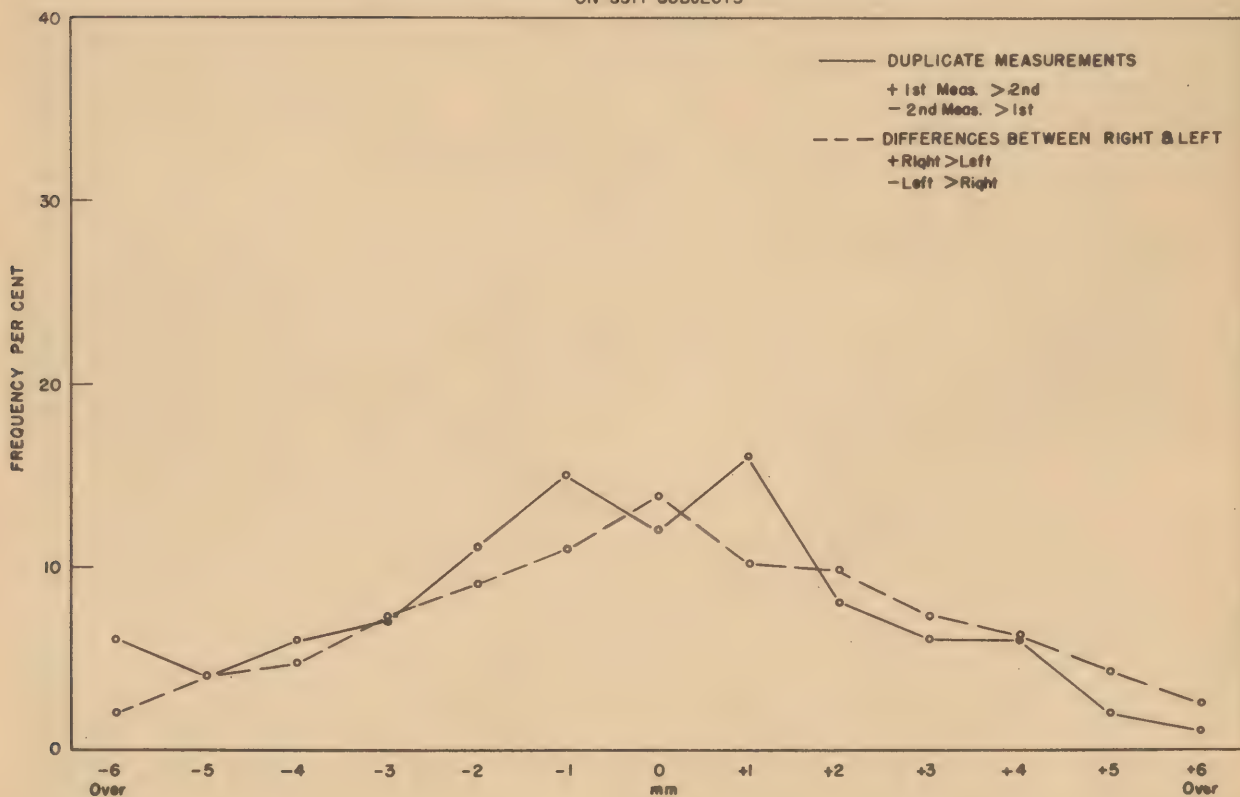


Figure 69



TABLE 31  
CORRELATION BETWEEN BALL GIRTH AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		BALL GIRTH									TOTAL
		mm. 219 & Less	220-229	230-239	240-249	250-259	260-269	270-279	280-289	290-Over	
		in.8 10/16 & Less	8 11/16-9"	9 1/16-9 7/16	9 7/16-9 13/16	9 10/16-10 3/16	10 4/16-10 9/16	10 10/16-11"	11" - 11 6/16	11 7/16 & Over	
mm.	in.										
84-89	3 5/16-3 8/16...										
90-95	3 9/16-3 12/16...			2							2
96-101	3 13/16-4".....			1	2						3
102-107	4"-4 3/16.....					1					1
108-113	4 4/16-4 7/16...										
114-119	4 8/16-4 11/16..										
120-125	4 12/16-4 15/16.										
TOTAL.....				3	2	1					6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16...	4	2	.....	.....	.....	.....	.....	.....	.....	6
90-95	3 9/16-3 12/16..	.....	1	12	12	2	.....	.....	.....	.....	27
96-101	3 13/16-4"	1	12	<u>21</u>	10	1	.....	.....	.....	.....	<u>45</u>
102-107	4"-4 3/16.....	.....	.....	2	3	2	2	.....	.....	.....	9
108-113	4 4/16-4 7/16...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		5	15	<u>35</u>	25	5	2	.....	.....	.....	87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16...	1	.....	1	.....	.....	.....	.....	.....	.....	2
90-95	3 9/16-3 12/16..	5	<u>39</u>	39	1	.....	.....	.....	.....	.....	84
96-101	3 13/16-4"	.....	7	133	<u>173</u>	13	.....	.....	.....	.....	<u>326</u>
102-107	4"-4 3/16.....	.....	.....	7	<u>44</u>	<u>72</u>	5	.....	.....	.....	128
108-113	4 4/16-4 7/16...	.....	.....	1	.....	<u>3</u>	<u>6</u>	1	.....	.....	11
114-119	4 8/16-4 11/16..	.....	.....	2	.....	.....	.....	1	.....	.....	3
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		6	46	183	<u>218</u>	88	11	2	.....	.....	554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16...	.....	.....	.....	.....	1	.....	.....	.....	.....	1
90-95	3 9/16-3 12/16..	1	20	<u>44</u>	1	.....	.....	.....	.....	.....	66
96-101	3 13/16-4"	.....	8	227	<u>376</u>	51	3	.....	.....	.....	665
102-107	4"-4 3/16.....	.....	1	8	<u>165</u>	<u>330</u>	56	.....	.....	.....	560
108-113	4 4/16-4 7/16...	.....	1	1	3	<u>25</u>	<u>42</u>	11	.....	.....	83
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	.....	.....	3	2	.....	5
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		1	30	280	<u>545</u>	407	101	14	2	.....	1380

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16..	.....	6	<u>16</u>	2	.....	.....	.....	.....	.....	24
96-101	3 13/16-4"	.....	7	109	<u>307</u>	51	1	.....	.....	.....	475
102-107	4"-4 3/16.....	.....	1	9	<u>215</u>	<u>618</u>	160	.....	.....	.....	<u>1005</u>
108-113	4 4/16-4 7/16...	.....	.....	2	4	<u>58</u>	<u>182</u>	2	.....	.....	286
114-119	4 8/16-4 11/16..	.....	.....	.....	2	2	<u>4</u>	<u>12</u>	.....	2	22
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		.....	14	136	530	<u>729</u>	347	54	.....	2	1812

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREATH		BALL GIRTH									TOTAL
		mm. 219 & Less	220-229	230-239	240-249	250-259	260-269	270-279	280-289	290-Over	
		in. 8 10/16 & Less	8 11/16-9"	9 1/16-9 7/16	9 7/16-9 13/16	9 10/16-10 3/16	10 4/16-10 9/16	10 10/16-11"	11" - 11 6/16	11 7/16 & Over	
mm.	in.										
84-89	3 5/16-3 8/16...										
90-95	3 9/16-3 12/16...	2	5			1				8	
96-101	3 13/16-4"		22	123	28	5				178	
102-107	4"-4 3/16...		2	98	380	133	6			619	
108-113	4 4/16-4 7/16...		2	5	47	226	64	3		347	
114-119	4 8/16-4 11/16...					4	32	10		46	
120-125	4 12/16-4 15/16.							4		4	
TOTAL.....		2	31	226	455	369	102	17		1202	

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16...										
90-95	3 9/16-3 12/16...			1				1			2
96-101	3 13/16-4"			2	18		1				21
102-107	4"-4 3/16...			1	19	82	52	3			157
108-113	4 4/16-4 7/16...					21	108	49	2		180
114-119	4 8/16-4 11/16...					1	4	32	20	1	58
120-125	4 12/16-4 15/16...								6		6
TOTAL				4	37	104	165	85	28	1	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16...										
90-95	3 9/16-3 12/16...										
96-101	3 13/16-4"				1						1
102-107	4"-4 3/16...					10	8	1			19
108-113	4 4/16-4 7/16...					4	22	11	1		38
114-119	4 8/16-4 11/16...						2	12	10		24
120-125	4 12/16-4 15/16...								4	2	6
TOTAL					1	14	32	24	15	2	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16...										
90-95	3 9/16-3 12/16...										
96-101	3 13/16-4"										
102-107	4"-4 3/16...					1	2				3
108-113	4 4/16-4 7/16...						1	1			2
114-119	4 8/16-4 11/16...						1	4	2		7
120-125	4 12/16-4 15/16...						1				1
TOTAL						1	5	5	2		13

# BALL HEIGHT

GENERAL - This dimension was measured as illustrated in the accompanying photograph (Fig. 70). 98% of the white population is included within a range of 7/16 in. The ball height which will accommodate 99% of the white men is 1 12/16 in. The Negro measurements are smaller than those of the white subjects. (Fig. 71, Table 32).



Figure 70  
Ball Height

CORRELATIONS - Ball height correlates poorly, if at all, with foot length and foot breadth. There is a pronounced scatter of the measurements such that a given foot length and/or breadth may be associated with a wide variety of ball heights (Table 33).

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be +0.1 mm., and the absolute mean difference without regard to sign was 1.2 mm. The range of differences is shown in Fig. 72.

TABLE 32  
BALL HEIGHT

No. Subjects	WHITE 5574		NEGRO 1199	
	mm.	in.	mm.	in.
Mean.....	38.8	1 9/16	38.1	1 8/16
100% range.....	20-49	13/16 - 1 15/16	32-46	1 4/16 - 1 13/16
98% range.....	33-44	1 5/16 - 1 12/16	33-43	1 5/16 - 1 11/16
95% range.....	34-43	1 5/16 - 1 11/16	34-42	1 5/16 - 1 11/16



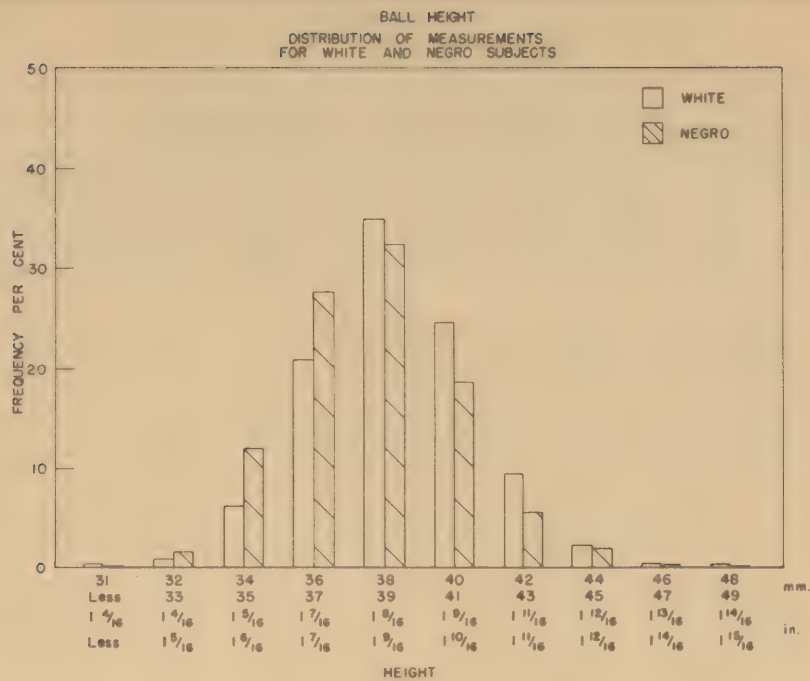


Figure 71

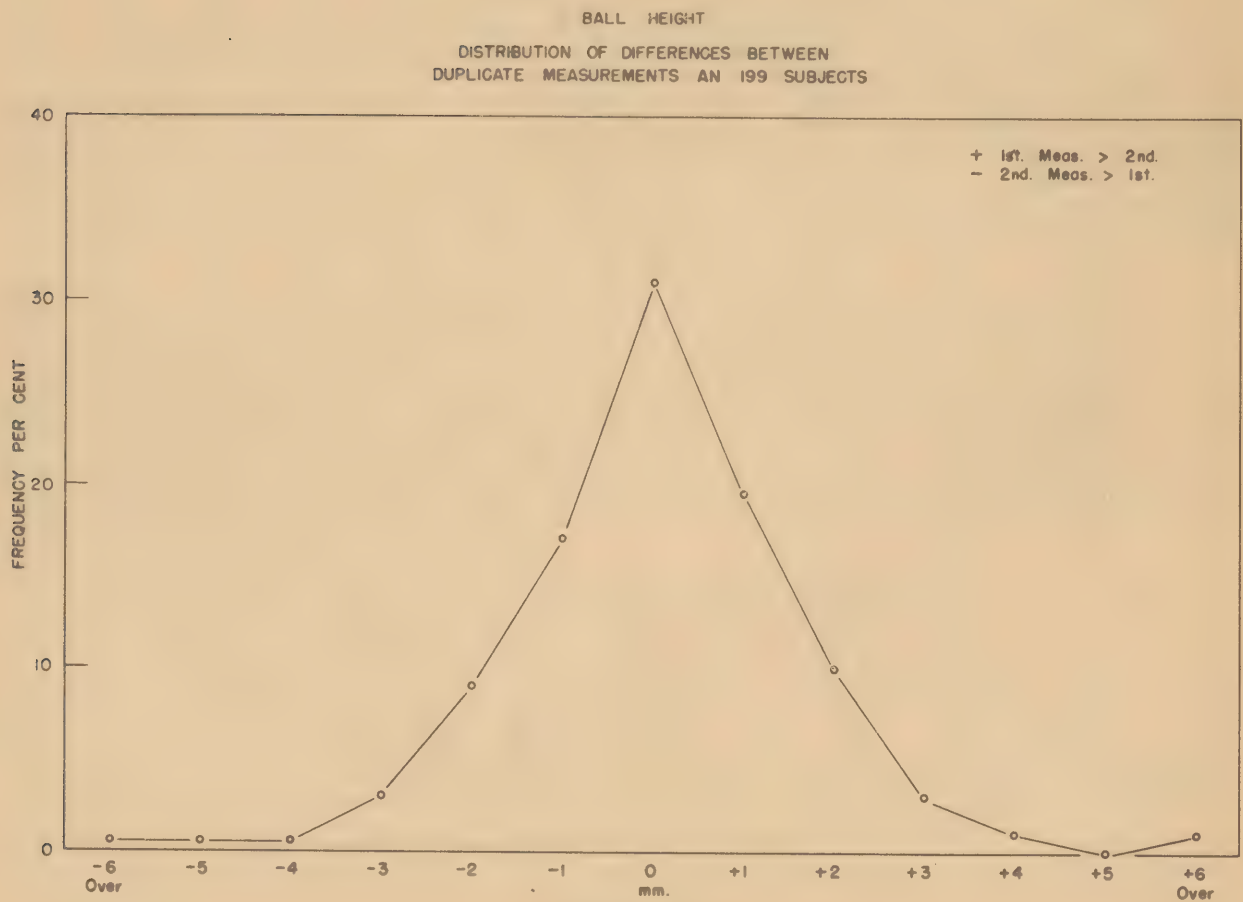


Figure 72

TABLE 33  
CORRELATION BETWEEN BALL HEIGHT AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

LENGTH GROUP 225 TO 254 mm. (8 14/16 TO 9 5/16 in.)												TOTAL
BALL HEIGHT												
DIAGONAL BREADTH	mm. 31 & Less	32-33	34-35	36-37	38-39	40-41	42-43	44-45	46-47	48-49		
	in. 1 4/16 & Less	1 4/16- 1 5/16	1 5/16- 1 6/16	1 7/16- 1 7/16	1 8/16- 1 9/16	1 9/16- 1 10/16	1 11/16- 1 11/16	1 12/16- 1 12/16	1 13/16- 1 14/16	1 14/16- 1 15/16		
mm.	in.											
84-89	3 5/16 - 3 8/16..											
90-95	3 9/16 - 3 12/16..			1	1						2	
96-101	3 13/16 - 4.....			1		1	1				3	
102-107	4 - 4 3/16.....					1					1	
108-113	4 4/16 - 4 7/16..											
114-119	4 8/16 - 4 11/16..											
120-125	4 12/16 - 4 15/16											
TOTAL.....			2	1	2	1					6	

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16 - 3 8/16..		1		4	1							6
90-95	3 9/16 - 3 12/16..			3	12	8	4						27
96-101	3 13/16 - 4.....		3	12	17	11	2						45
102-107	4 - 4 3/16.....		1		5		1	1	1				9
108-113	4 4/16 - 4 7/16..												
114-119	4 8/16 - 4 11/16..												
120-125	4 12/16 - 4 15/16												
TOTAL.....			5	15	38	20	7	1	1				87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16 - 3 8/16..				1	1							2
90-95	3 9/16 - 3 12/16..	1	5	23	35	15	4	1					84
96-101	3 13/16 - 4.....		8	50	113	100	44	7	2	1			325
102-107	4 - 4 3/16.....		1	13	42	40	19	11	2				128
108-113	4 4/16 - 4 7/16..			2	3	3							11
114-119	4 8/16 - 4 11/16..		1		1	1							3
120-125	4 12/16 - 4 15/16												
TOTAL.....		1	15	88	195	160	70	19	4	1			553

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16 - 3 8/16..						1						1
90-95	3 9/16 - 3 12/16..			12	26	17	9	1		1			66
96-101	3 13/16 - 4.....	3	10	80	200	236	108	25	2		1		665
102-107	4 - 4 3/16.....	2	3	35	123	224	125	37	11				560
108-113	4 4/16 - 4 7/16..	1	1	3	15	29	21	9	4				83
114-119	4 8/16 - 4 11/16..						1	1	1	2			5
120-125	4 12/16 - 4 15/16												
TOTAL.....		6	14	130	364	506	265	73	18	3	1		1380

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16 - 3 8/16..							1					24
90-95	3 9/16 - 3 12/16..			8	2	9	4	1					475
96-101	3 13/16 - 4.....	3	1	33	125	195	90	23		1			1005
102-107	4 - 4 3/16.....	2	8	30	184	394	278	97	12				288
108-113	4 4/16 - 4 7/16..	3		7	44	96	94	31	11	1	1		20
114-119	4 8/16 - 4 11/16..				3	8	3	4	2				
120-125	4 12/16 - 4 15/16												
TOTAL.....		8	9	78	358	702	469	156	29	2	1		1812

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		BALL HEIGHT										TOTAL	
		mm.	31 & Less	32-33	34-35	36-37	38-39	40-41	42-43	44-45	46-47		48-49
		in.	1 4/16 & Less	1 4/16-1 5/16	1 5/16-1 6/16	1 7/16-1 7/16	1 8/16-1 9/16	1 9/16-1 10/16	1 11/16-1 11/16	1 12/16-1 12/16	1 13/16-1 14/16		1 14/16-1 15/16
mm.	in.												
84-89	3 5/16 - 3 8/16..												8
90-95	3 9/16 - 3 12/16..			3	3	2							8
96-101	3 13/16 - 4.....	1		8	38	67	54	8	2				178
102-107	4 - 4 3/16.....	1	3	14	82	231	185	84	14	4	1		619
108-113	4 4/16 - 4 7/16..	2	1	5	34	106	123	62	10	3	1		347
114-119	4 8/16 - 4 11/16..				5	11	12	11	4	1	2		46
120-125	4 12/16 - 4 15/16	1			1	1		1					4
TOTAL.....		5	4	30	163	418	374	166	30	8	4		1202

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16 - 3 8/16..												2
90-95	3 9/16 - 3 12/16..					1		1					2
96-101	3 13/16 - 4.....			1	3	7	5	5					21
102-107	4 - 4 3/16.....			2	19	53	46	25	9	3			157
108-113	4 4/16 - 4 7/16..		1	1	10	49	61	35	21	1	1		180
114-119	4 8/16 - 4 11/16..			1	3	7	20	19	7		1		58
120-125	4 12/16 - 4 15/16					1	4	1					6
TOTAL.....			1	5	36	117	136	86	37	4	2		424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16 - 3 8/16..												
90-95	3 9/16 - 3 12/16..												
96-101	3 13/16 - 4.....							1					1
102-107	4 - 4 3/16.....				1	4	11	2	1				19
108-113	4 4/16 - 4 7/16..	1			1	7	13	10	3	2	1		38
114-119	4 8/16 - 4 11/16..				1	3	10	8	2				24
120-125	4 12/16 - 4 15/16					1	3	1	1				6
TOTAL.....		1			3	15	37	22	7	2	1		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16 - 3 8/16..												
90-95	3 9/16 - 3 12/16..												
96-101	3 13/16 - 4.....												
102-107	4 - 4 3/16.....					1		2					3
108-113	4 4/16 - 4 7/16..						1	1					2
114-119	4 8/16 - 4 11/16..					1	3		2	1			7
120-125	4 12/16 - 4 15/16							1					1
TOTAL.....						2	4	4	2	1			13



## OUTSIDE BALL HEIGHT

GENERAL - This dimension was measured as indicated in the accompanying photograph (Fig. 73). 98% of the white population is included within a range of 6/16 in. The outside ball height which will accommodate 99% of the white men is 1 3/16 in., or about 2/3 of the ball height. The Negro measurements are smaller than those of the white subjects (Fig. 74, Table 34).



Figure 73  
Outside Ball Height

CORRELATIONS - Outside ball height correlates poorly, if at all, with foot length and with foot breadth. There is a pronounced scatter of the measurements such that a given foot length and/or breadth may be associated with a wide variety of outside ball heights (Table 35).

DUPLICATE MEASUREMENTS - The algebraic mean difference between duplicate measurements was found to be -0.2 mm., and the absolute mean difference without regard to sign was 1.3 mm. The range of differences is shown in Fig. 75.

TABLE 34  
OUTSIDE BALL HEIGHT

No. Subjects	WHITE 5571		NEGRO 1198	
	mm.	in.	mm.	in.
Mean .....	25.4	1	24.9	15/16
100% range ....	18-40	11/16 - 1 9/16	16-37	10/16 - 1 7/16
98% " ....	20-30	13/16 - 1 3/16	20-30	13/16 - 1 3/16
95% " ....	22-29	14/16 - 1 2/16	21-29	13/16 - 1 2/16

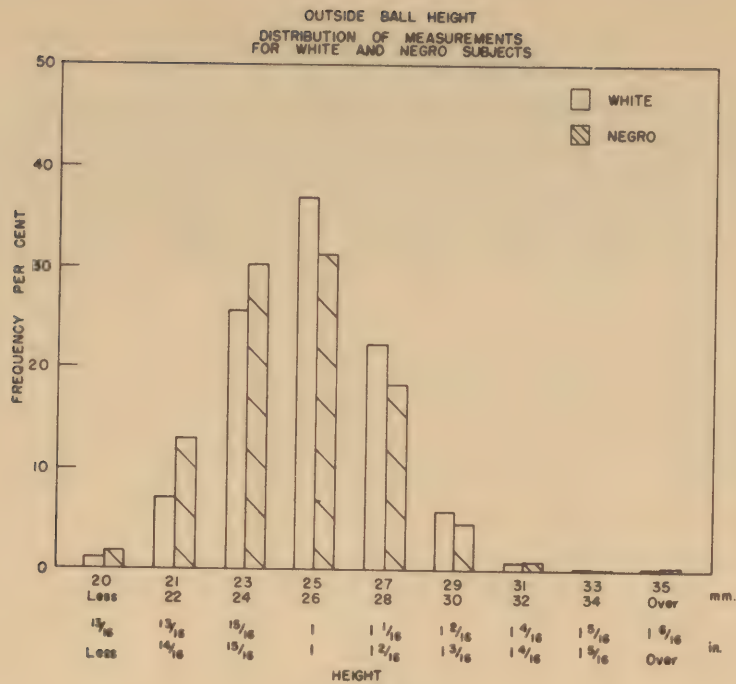


Figure 74

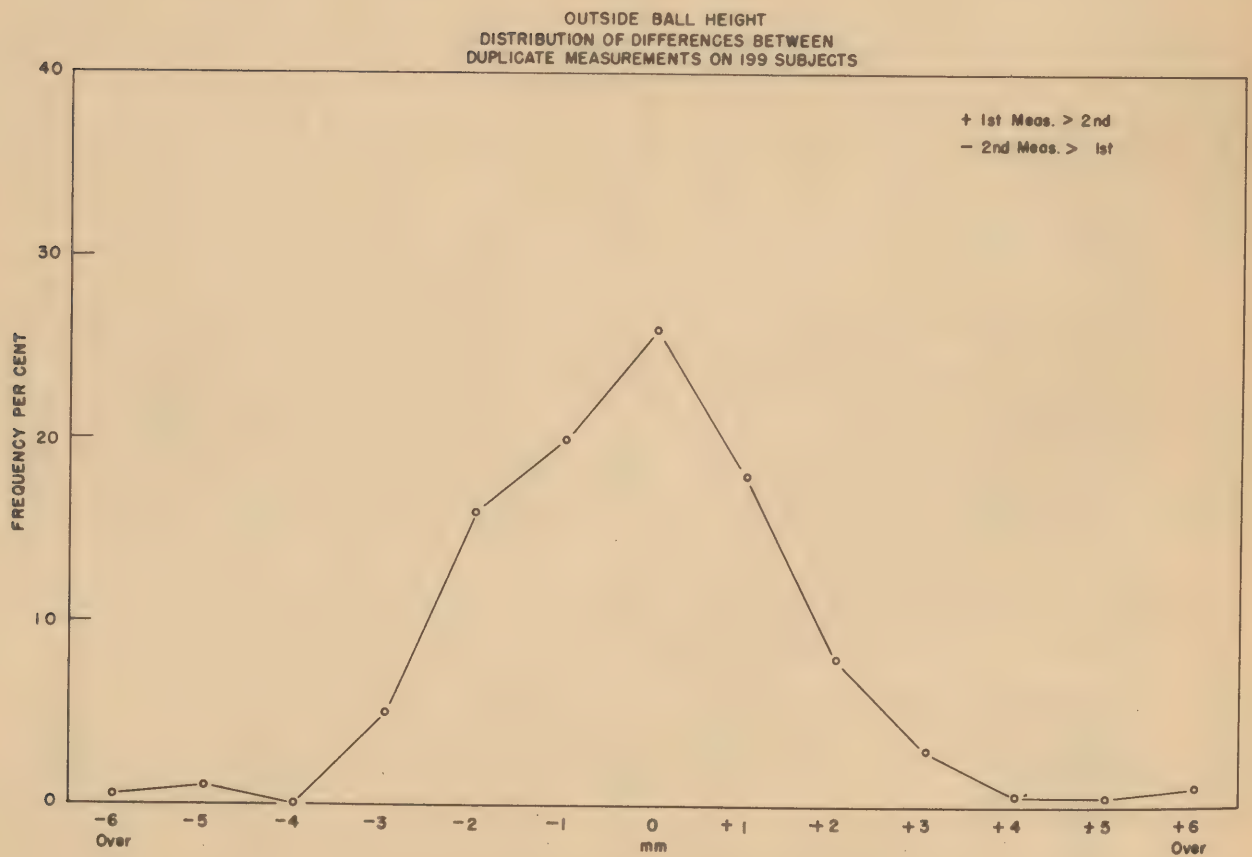


Figure 75

TABLE 35  
CORRELATION BETWEEN OUTSIDE BALL HEIGHT AND LENGTH AND  
BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		OUTSIDE BALL HEIGHT								TOTAL	
		mm. 20 & Less	21-22	23-24	25-26	27-28	29-30	31-32	33-34		35-Over
		in. 13/16 & Less	13/16-14/16	15/16-15/16	1"-1"	1 1/16 1 2/16	1 2/16 1 3/16	1 4/16 1 4/16	1 5/16 1 5/16		1 6/16 & Over
mm.	in.										
84-89	3 5/16-3 8/16..										
90-95	3 9/16-3 12/16..				1	1					2
96-101	3 13/16-4.....			1	2						3
102-107	4 -4 3/16.....				1						1
108-113	4 4/16-4 7/16..										
114-119	4 8/16-4 11/16..										
120-125	4 12/16-4 15/16										
TOTAL.....				1	4	1					6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16..	1		4	1						6
90-95	3 9/16-3 12/16..		7	<u>10</u>	9	1					27
96-101	3 13/16-4.....	2	8	<u>21</u>	12	2					45
102-107	4 -4 3/16.....		3	4		2					9
108-113	4 4/16-4 7/16..										
114-119	4 8/16-4 11/16..										
120-125	4 12/16-4 15/16										
TOTAL.....		3	18	<u>39</u>	22	5					87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16..				2						2
90-95	3 9/16-3 12/16..	2	15	34	23	10					84
96-101	3 13/16-4.....	8	46	<u>113</u>	101	50	8				326
102-107	4 -4 3/16.....	1	11	42	47	21	4	1		1	128
108-113	4 4/16-4 7/16..		3	5		3					11
114-119	4 8/16-4 11/16..		2		1						3
120-125	4 12/16-4 15/16										
TOTAL.....		11	77	<u>194</u>	174	84	12	1		1	554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16..				1						1
90-95	3 9/16-3 12/16..	1	11	18	<u>30</u>	6					66
96-101	3 13/16-4.....	14	68	223	<u>244</u>	103	13				665
102-107	4 -4 3/16.....	6	42	140	<u>218</u>	120	25	4	1	1	557
108-113	4 4/16-4 7/16..		2	16	<u>30</u>	26	9				83
114-119	4 8/16-4 11/16..				3	2					5
120-125	4 12/16-4 15/16										
TOTAL.....		21	123	397	<u>526</u>	257	47	4	1	1	1377

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16..										
90-95	3 9/16-3 12/16..		3	12	7	1	1				24
96-101	3 13/16-4.....	9	45	145	<u>181</u>	82	10	1		1	474
102-107	4 -4 3/16.....	7	52	264	<u>383</u>	235	59	4	1		1005
108-113	4 4/16-4 7/16..	4	11	46	<u>106</u>	80	31	6	1	1	286
114-119	4 8/16-4 11/16..	1	1	2	8	7	2	1			22
120-125	4 12/16-4 15/16										
TOTAL.....		21	112	469	<u>685</u>	405	103	12	2	2	1811



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		OUTSIDE BALL HEIGHT								TOTAL
		mm. 20 & Less	21-22	23-24	25-26	27-28	29-30	31-32	33-34	
		in. 13/16 & Less	13/16-14/16	15/16-15/16	1"-1"	1 1/16 1 2/16	1 2/16 1 3/16	1 4/16 1 4/16	1 5/16 1 5/16	
mm.	in.									
84-89	3 5/16-3 8/16..									
90-95	3 9/16-3 12/16..		1	3	2	2				8
96-101	3 13/16-4.....	1	13	50	69	35	7	3		178
102-107	4-4 3/16.....	2	33	142	236	162	37	7		619
108-113	4 4/16-4 7/16..	2	12	58	120	112	37	5		347
114-119	4 8/16-4 11/16..		1	1	20	12	10	2		46
120-125	4 12/16-4 15/16				2	1			1	4
TOTAL.....		5	60	254	449	324	91	17	2	1702

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..									
90-95	3 9/16-3 12/16..				1	1				2
96-101	3 13/16-4.....		1	5	10	3	2			21
102-107	4-4 3/16.....		4	26	60	47	18	2		157
108-113	4 4/16-4 7/16..		1	23	63	65	23	5		180
114-119	4 8/16-4 11/16..			4	16	19	15	3	1	58
120-125	4 12/16-4 15/16				2	3	1			6
TOTAL.....			6	58	152	138	59	10	1	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16..									
90-95	3 9/16-3 12/16..									
96-101	3 13/16-4.....				1					1
102-107	4-4 3/16.....			2	8	7	2			19
108-113	4 4/16-4 7/16..		1	8	16	10	3			38
114-119	4 8/16-4 11/16..			2	5	11	5	1		24
120-125	4 12/16-4 15/16			1	3	1	1			6
TOTAL.....			1	13	33	29	11	1		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..									
90-95	3 9/16-3 12/16..									
96-101	3 13/16-4.....									
102-107	4-4 3/16.....				1	1	1			3
108-113	4 4/16-4 7/16..				1	1				2
114-119	4 8/16-4 11/16..			1	2	1	3			7
120-125	4 12/16-4 15/16							1		1
TOTAL.....				1	4	3	4	1		13

# ANGULAR ORIENTATION OF THE METATARSAL HEADS

GENERAL - This dimension was measured from a photograph of the sole as illustrated (Fig. 76). It is one measure of the orientation of the metatarsal region of the foot to the posterior portion, and provides a frame of reference for interpreting the measurements of the diagonal breadth of the foot. 98% of the white population is included with a range of  $14^{\circ}$ . The Negro measurements tend to be larger than those of the white subjects (Fig. 77, Table 36).



CORRELATION - The angular orientation of the metatarsal heads correlates poorly, if at all, with foot length and with foot breadth. There is a pronounced scatter of the measurements such that a given foot length and/or breadth may be associated with a wide variety of metatarsal angles (Table 37).

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be zero, and the absolute mean difference without regard to sign was  $1.6^{\circ}$ . The range of differences is shown in Fig. 78.

NOTE - In the description of the characteristics of the anterior toe curvatures the range of angular orientation of the metatarsal heads for 95% of the population has been taken into account.

Figure 76  
Angular Orientation of  
Metatarsal Heads

TABLE 36  
ANGULAR ORIENTATION OF THE METATARSAL HEADS

No. Subjects		WHITE 5566	NEGRO 1197	
		Degrees		Degrees
Mean .....		86.3		87.3
100% range ....		75-99		76-98
98% " ....		79-93		81-93
95% " ....		81-91		82-92

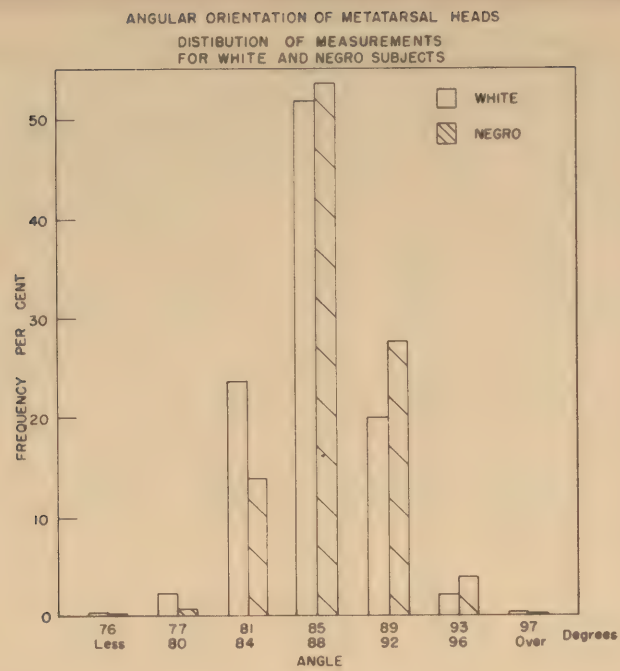


Figure 77

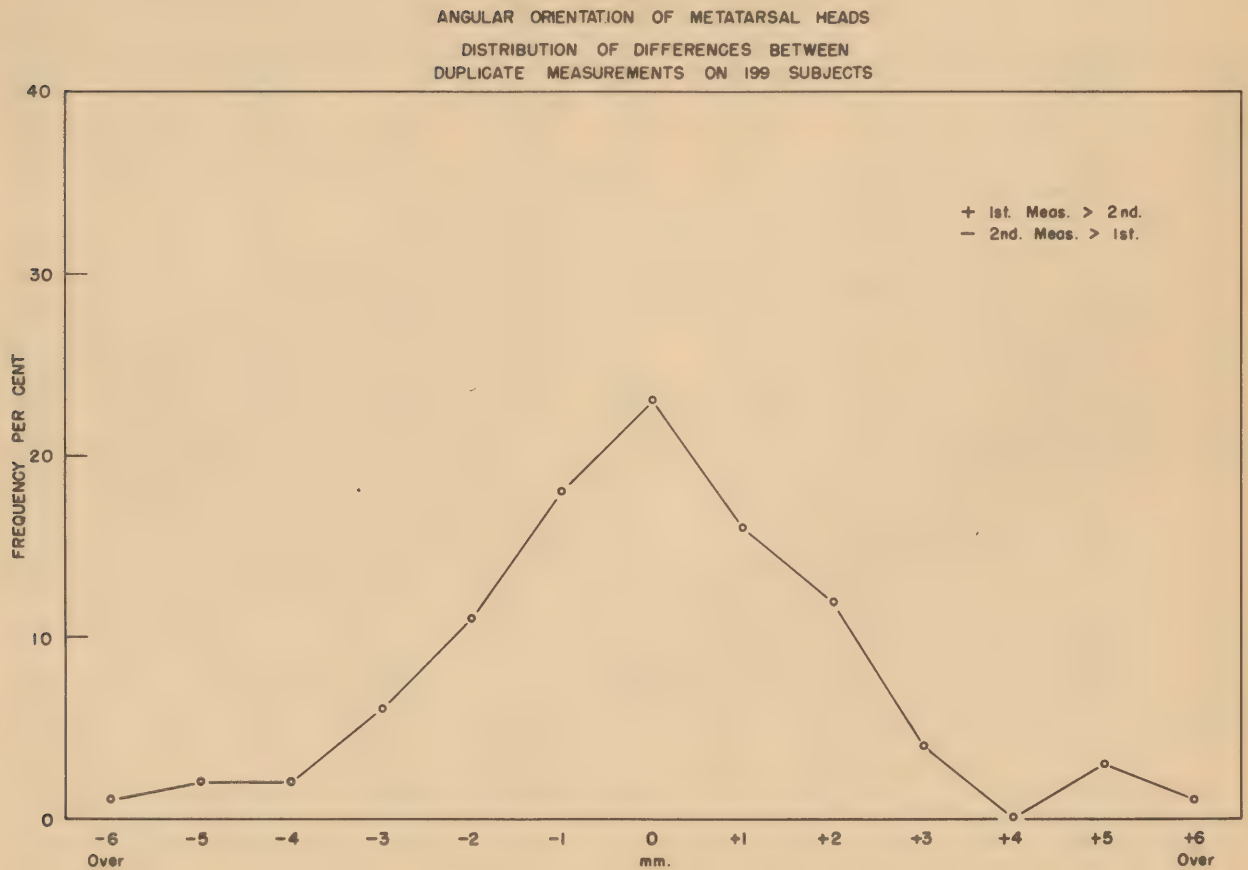


Figure 78



TABLE 37  
CORRELATION BETWEEN THE ANGULAR ORIENTATION OF THE METATARSAL  
HEADS AND LENGTH AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

		LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)						
DIAGONAL BREADTH	Degrees	ANGULAR ORIENTATION OF METATARSAL HEADS						TOTAL
		76-Less	77-80	81-84	85-88	89-92	93-96	
mm.	in.							
84-89	3 5/16-3 8/16..							
90-95	3 9/16-3 12/16.			1	1			2
96-101	3 13/16-4 .....		1	1	1			3
102-107	4 1/4-3 3/16.....			1				1
108-113	4 4/16-4 7/16..							
114-119	4 8/16-4 11/16.							
120-125	4 12/16-4 15/16							
TOTAL.....			1	3	2			6

		LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)						
mm.	in.							
84-89	3 5/16-3 8/16..			2	2	2		6
90-95	3 9/16-3 12/16.	1	1	11	14			27
96-101	3 13/16-4 .....		2	13	20	9	1	45
102-107	4 1/4-3 3/16.....			5	3		1	9
108-113	4 4/16-4 7/16..							
114-119	4 8/16-4 11/16.							
120-125	4 12/16-4 15/16							
TOTAL.....		1	3	31	39	11	2	87

		LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)						
mm.	in.							
84-89	3 5/16-3 8/16..			1		1		2
90-95	3 9/16-3 12/16.		1	18	48	15	1	83
96-101	3 13/16-4 .....	1	8	106	167	41	2	326
102-107	4 1/4-3 3/16.....		10	36	65	16	1	128
108-113	4 4/16-4 7/16..			3	6	2		11
114-119	4 8/16-4 11/16.			3				3
120-125	4 12/16-4 15/16							
TOTAL.....		1	19	167	286	75	4	553

		LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)						
mm.	in.							
84-89	3 5/16-3 8/16..			1				1
90-95	3 9/16-3 12/16.			17	37	12		66
96-101	3 13/16-4 .....		19	163	354	116	12	665
102-107	4 1/4-3 3/16.....		14	168	285	87	5	560
108-113	4 4/16-4 7/16..		5	21	45	10	2	83
114-119	4 8/16-4 11/16.		1	1	2	1		5
120-125	4 12/16-4 15/16							
TOTAL.....			39	371	723	226	19	1380

		LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)						
mm.	in.							
84-89	3 5/16-3 8/16..							
90-95	3 9/16-3 12/16.			1	21	1	1	24
96-101	3 13/16-4 .....	1	9	98	246	101	20	475
102-107	4 1/4-3 3/16.....		22	245	516	210	12	1005
108-113	4 4/16-4 7/16..	1	8	88	137	50	2	286
114-119	4 8/16-4 11/16.		1	7	11	3		22
120-125	4 12/16-4 15/16							
TOTAL.....		2	40	439	931	365	35	1812

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH	Degrees	ANGULAR ORIENTATION OF METATARSAL HEADS							TOTAL
		76-Less	77-80	81-84	85-88	89-92	93-96	97-Over	
mm.	in.								
84-89	3 5/16-3 8/16..								
90-95	3 9/16-3 12/16..			1	5	2			8
96-101	3 13/16-4.....			14	<u>104</u>	55	5		178
102-107	4 4 3/16.....		12	115	<u>326</u>	152	14		619
108-113	4 4/16-4 7/16..		8	74	<u>186</u>	72	7		347
114-119	4 8/16-4 11/16..	2		11	25	8			46
120-125	4 12/16-4 15/16			2	2				4
TOTAL.....		2	20	217	<u>648</u>	289	26		1202

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..								
90-95	3 9/16-3 12/16..				2				2
96-101	3 13/16-4.....				<u>10</u>	9		2	21
102-107	4 4 3/16.....		1	28	<u>77</u>	43	8		157
108-113	4 4/16-4 7/16..	1		31	<u>83</u>	52	12		179
114-119	4 8/16-4 11/16..		3	8	<u>35</u>	11	1		58
120-125	4 12/16-4 15/16			1	<u>4</u>	1			6
TOTAL.....		1	4	68	<u>211</u>	116	21	2	423

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16..								
90-95	3 9/16-3 12/16..								
96-101	3 13/16-4.....				1				1
102-107	4 4 3/16.....			2	<u>11</u>	6			19
108-113	4 4/16-4 7/16..			4	<u>21</u>	9	4		38
114-119	4 8/16-4 11/16..			<u>10</u>	9	3	2		24
120-125	4 12/16-4 15/16			1	1	4			6
TOTAL.....				17	<u>43</u>	22	6		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..								
90-95	3 9/16-3 12/16..								
96-101	3 13/16-4.....								
102-107	4 4 3/16.....					2	1		3
108-113	4 4/16-4 7/16..				2				2
114-119	4 8/16-4 11/16..			1	2	4			7
120-125	4 12/16-4 15/16				1				1
TOTAL.....				1	5	6	1		13

## LATERAL FOOT CONTOUR



Figure 79  
Lateral Foot Contour

GENERAL - This dimension was measured from a photograph of the sole as illustrated (Fig. 79). Transparent plastic templates were used to describe the relation of the lateral toe margin to the lateral margin of the foot. The shapes encountered and their frequency are shown in Fig. 80.

CORRELATIONS - The lateral foot contour correlates only moderately well with foot breadth and poorly, if at all, with foot length. There is a pronounced scatter of shapes such that a given foot length and/or breadth may be associated with a wide variety of countours of the lateral margin of the foot (Table 38).

DUPLICATE MEASUREMENTS - Duplicate photographs were examined for 199 subjects. In 43% of the cases the selection of templates was identical, and in 48% the selection on the 2nd series differed from the first by one shape unit. Thus, 91% of the duplicates were, for all practical purposes, in agreement, since the difference between successive shape units was small (App 2, Fig. 13B). 8.5% differed by 2 space units and 0.5% by more than 2 space units.



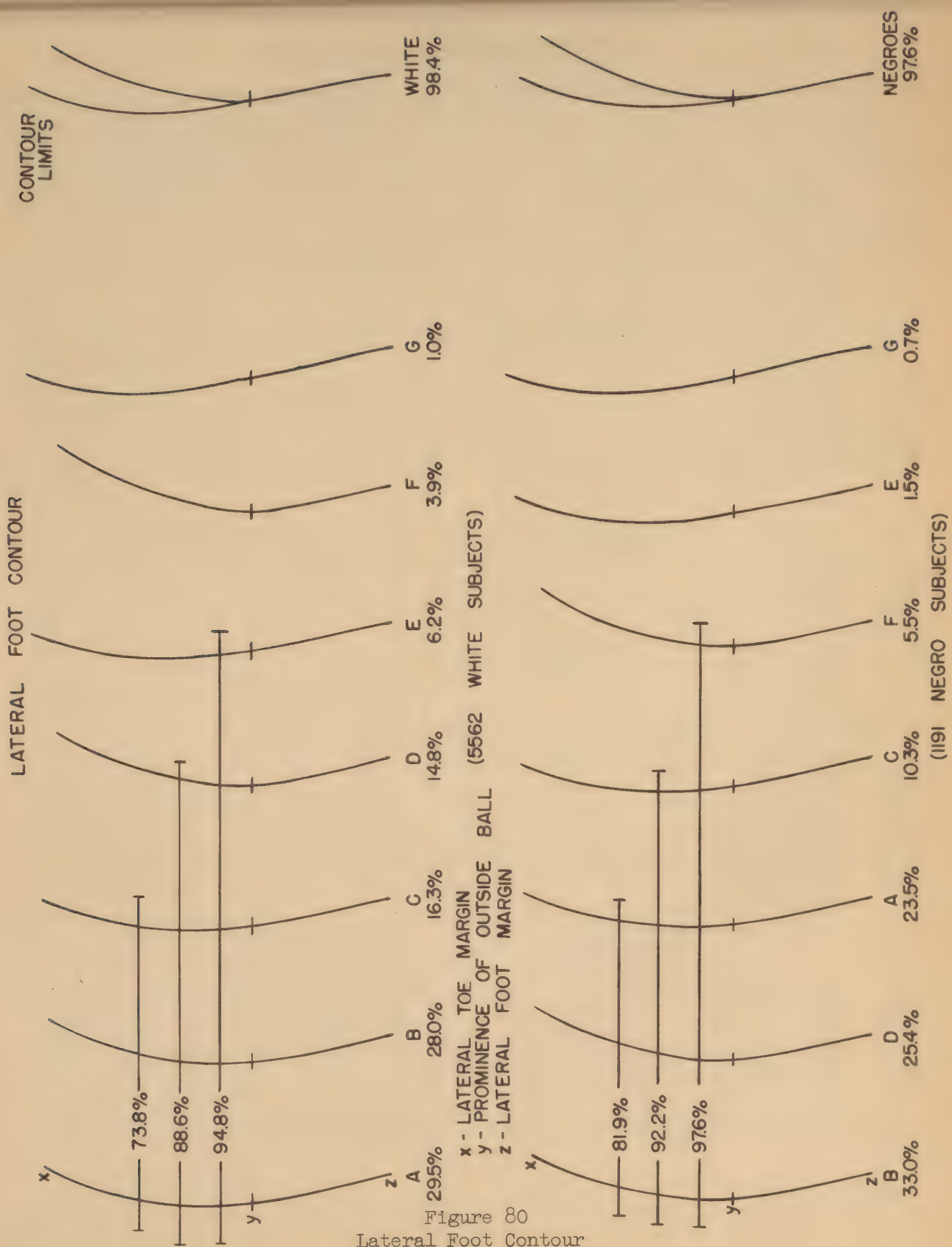


TABLE 38  
CORRELATION BETWEEN LATERAL FOOT CONTOUR AND LENGTH  
AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		LATERAL FOOT CONTOUR								TOTAL
		0	1	2	3	4	5	6	7	
mm.	in.									
84-89	3 5/16-3 8/16...									
90-95	3 9/16-3 12/16..				1	1				2
96-101	3 13/16-4.....				1	1	1			3
102-107	4 -4 3/16.....						1			1
108-113	4 4/16-4 7/16...									
114-119	4 8/16-4 11/16..									
120-125	4 12/16-4 15/16.									
TOTAL.....					2	2	2			6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16...	.....	.....	1	1	2	1	.....	1	.....	6
90-95	3 9/16-3 12/16..	.....	.....	1	1	<u>11</u>	9	4	1	.....	27
96-101	3 13/16-4.....	.....	.....	3	6	<u>11</u>	<u>19</u>	3	3	.....	<u>45</u>
102-107	4 -4 3/16.....	.....	.....	.....	1	2	<u>6</u>	.....	.....	.....	<u>9</u>
108-113	4 4/16-4 7/16...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		.....	.....	5	9	26	<u>35</u>	7	5	.....	87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16...	.....	.....	1	.....	1	.....	.....	.....	.....	2
90-95	3 9/16-3 12/16..	1	1	9	14	<u>30</u>	19	7	1	1	83
96-101	3 13/16-4.....	.....	5	21	59	<u>95</u>	76	58	10	2	<u>326</u>
102-107	4 -4 3/16.....	.....	1	4	17	<u>34</u>	<u>39</u>	26	7	.....	<u>128</u>
108-113	4 4/16-4 7/16...	.....	.....	.....	.....	4	3	2	2	.....	11
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	.....	2	.....	1	.....	3
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		1	7	35	90	<u>164</u>	139	93	21	3	553

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16...	.....	.....	.....	.....	1	.....	.....	.....	.....	1
90-95	3 9/16-3 12/16..	1	2	8	23	15	9	7	1	.....	66
96-101	3 13/16-4.....	9	47	145	<u>188</u>	181	82	13	.....	.....	<u>665</u>
102-107	4 -4 3/16.....	.....	4	25	<u>59</u>	<u>175</u>	159	100	36	.....	<u>558</u>
108-113	4 4/16-4 7/16...	1	.....	4	6	<u>21</u>	<u>23</u>	21	7	.....	83
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	1	<u>3</u>	1	.....	.....	5
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		11	53	182	276	<u>394</u>	276	142	44	.....	1378

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16..	.....	.....	3	6	2	5	.....	.....	.....	23
96-101	3 13/16-4.....	.....	7	50	91	<u>150</u>	116	48	10	2	474
102-107	4 -4 3/16.....	2	5	42	167	<u>311</u>	278	148	49	1	<u>1003</u>
108-113	4 4/16-4 7/16...	.....	1	10	32	<u>78</u>	87	62	13	3	<u>286</u>
114-119	4 8/16-4 11/16..	.....	.....	.....	2	7	<u>8</u>	3	2	.....	22
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		2	13	105	298	<u>555</u>	494	261	74	6	1808

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		LATERAL FOOT CONTOUR									TOTAL
		0	1	2	3	4	5	6	7	8	
mm.	in.										
84-89	3 5/16-3 8/16...										
90-95	3 9/16-3 12/16..			1	2	4	1				8
96-101	3 13/16-4.....	2	3	17	36	57	44	16	2	1	178
102-107	4 -4 3/16.....		9	41	107	180	180	83	17	1	618
108-113	4 4/16-4 7/16...		2	8	43	93	124	61	16		347
114-119	4 8/16-4 11/16..			3	2	13	19	4	5		46
120-125	4 12/16-4 15/16.					1		1	2		4
TOTAL.....		2	14	70	190	348	368	165	42	2	1201

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16...										
90-95	3 9/16-3 12/16..					2					2
96-101	3 13/16-4.....		1	2	5	8	3	2			21
102-107	4 -4 3/16.....	1	2	15	28	53	34	21	3		157
108-113	4 4/16-4 7/16...		1	16	25	41	58	31	7		179
114-119	4 8/16-4 11/16..		1	2	6	14	21	10	4		58
120-125	4 12/16-4 15/16.					1	2	2	1		6
TOTAL.....		1	5	35	64	119	118	66	15		423

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16...										
90-95	3 9/16-3 12/16..										
96-101	3 13/16-4.....			1							1
102-107	4 -4 3/16.....			2	6	3	4	4			19
108-113	4 4/16-4 7/16...			3	6	13	10	4	2		38
114-119	4 8/16-4 11/16..			2	3	6	7	6			24
120-125	4 12/16-4 15/16.				1		3	2			6
TOTAL.....				8	16	22	24	16	2		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16...										
90-95	3 9/16-3 12/16..										
96-101	3 13/16-4.....										
102-107	4 -4 3/16.....				2		1				3
108-113	4 4/16-4 7/16...			1				1			2
114-119	4 8/16-4 11/16..				1	4	1	1			7
120-125	4 12/16-4 15/16.						1				1
TOTAL.....				1	3	4	3	2			13



GENERAL - This dimension was measured as illustrated in the accompanying photograph (Fig. 81). It represents the height of the plantar curvature of the arch from the ground to the point of merger of the curvature of the arch with the vertical aspect of the medial foot surface in the plane defined by the line of junction of the foot and leg. 98% of the white population is included within a range of 14/16 in. The Negro measurements tend to be smaller than those of the white subjects (Fig. 82, Table 39).



CORRELATION - Plantar arch height correlates poorly, if at all, with foot length and with foot breadth. There is a pronounced scatter of the measurements, such that a given foot length and/or breadth may be associated with a wide variety of arch heights. (Table 40).

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be +0.2 mm., and the absolute mean difference without regard to sign was 2.0 mm. The range of differences is shown in Fig. 83.

Figure 81. Plantar Arch Height

TABLE 39  
PLANTAR ARCH HEIGHT

No. Subjects		WHITE 5572		NEGRO 1200	
		mm.	in.	mm.	in.
Mean .....		28.3	1 2/16	26.5	1 1/16
100% range ....		12-51	8/16 - 2	11-46	7/16 - 1 13/16
98% " ....		17-40	11/16 - 1 9/16	15-37	9/16 - 1 7/16
95% " ....		18-37	11/16 - 1 7/16	16-36	10/16 - 1 7/16

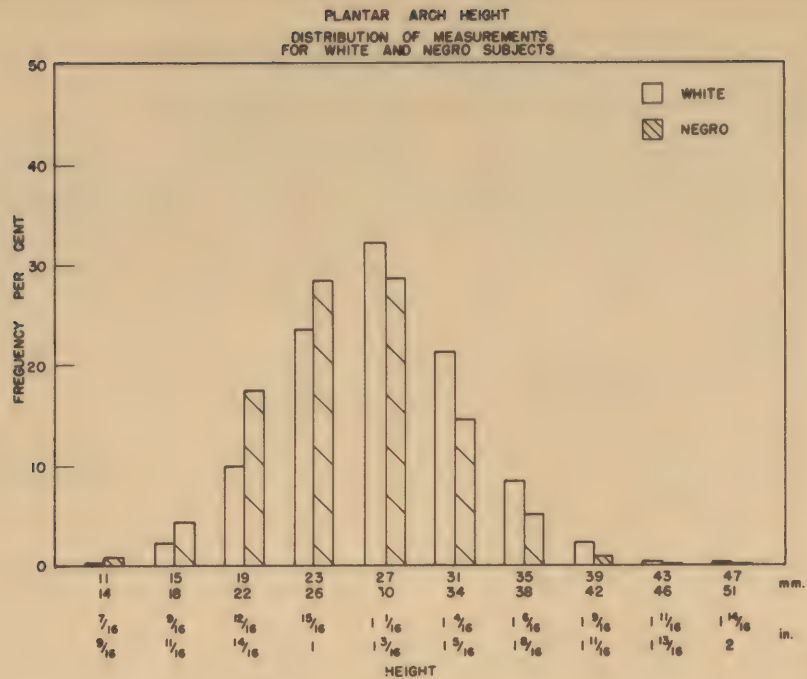


Figure 82

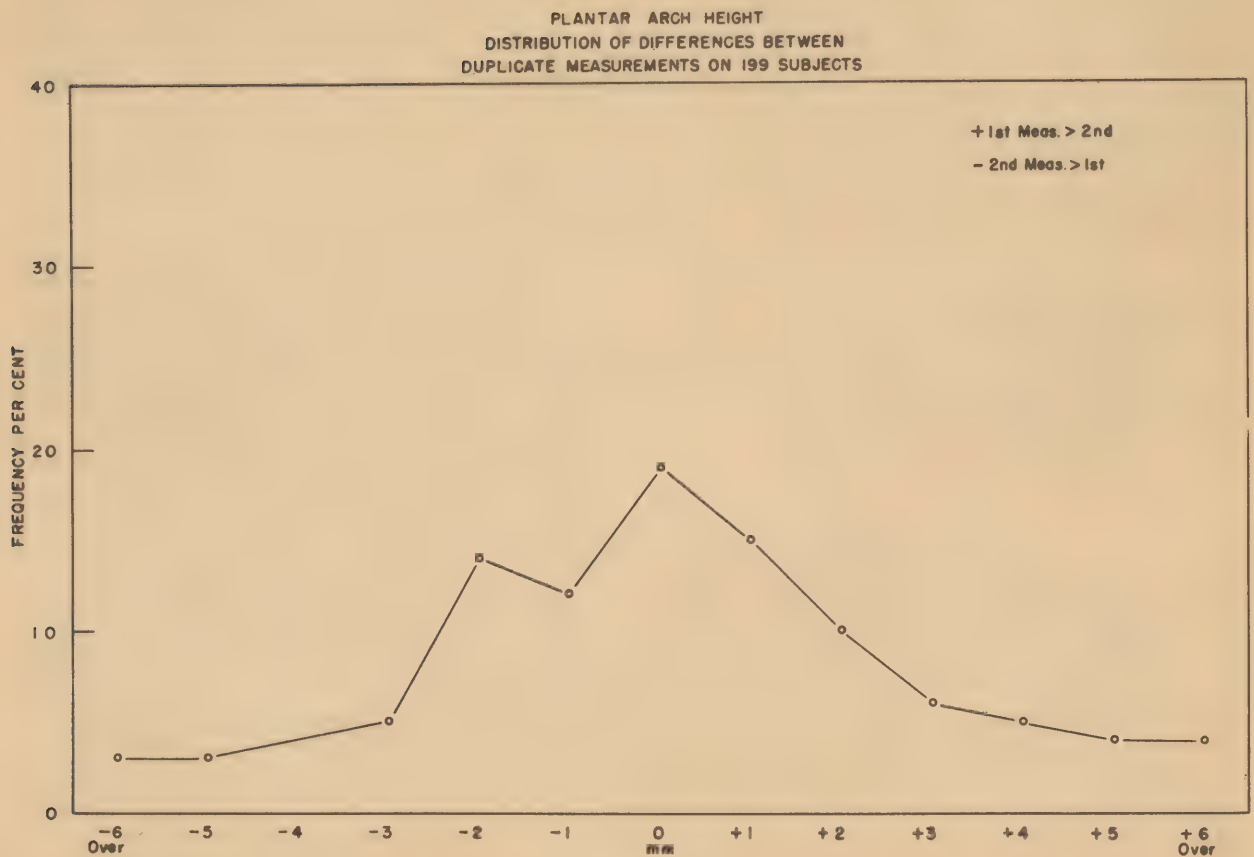


Figure 83

TABLE 40  
CORRELATION BETWEEN PLANTAR ARCH HEIGHT AND LENGTH  
AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		PLANTAR ARCH HEIGHT										TOTAL
		mm. 11-14	15-18	19-22	23-26	27-30	31-34	35-38	39-42	43-46	47-50	
		in. 7/16-9/16	9/16-11/16	12/16-14/16	15/16-1	1 1/16-1 3/16	1 4/16-1 5/16	1 6/16-1 8/16	1 9/16-1 11/16	1 11/16-1 13/16	1 14/16-2	
84-89	3 5/16-3 8/16...											
90-95	3 9/16-3 12/16...				1		1					2
96-101	3 13/16-4				2		1					3
102-107	4 -4 3/16					1						1
108-113	4 4/16-4 7/16...											
114-119	4 8/16-4 11/16...											
120-125	4 12/16-4 15/16...											
TOTAL.....					3	1	2					6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16...			1	1	3	1					6
90-95	3 9/16-3 12/16...		1		5	11	6	3	1			27
96-101	3 13/16-4			6	7	13	12	5	1	1		45
102-107	4 -4 3/16			2		3	4					9
108-113	4 4/16-4 7/16...											
114-119	4 8/16-4 11/16...											
120-125	4 12/16-4 15/16...											
TOTAL.....			1	9	13	30	23	8	2	1		87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16...				1	1						2
90-95	3 9/16-3 12/16...	1	4	10	16	30	20	3				84
96-101	3 13/16-4		3	30	81	102	71	31	7		1	326
102-107	4 -4 3/16			11	19	55	26	14	3			128
108-113	4 4/16-4 7/16...				4	3	1	3				11
114-119	4 8/16-4 11/16...				1	2						3
120-125	4 12/16-4 15/16...											
TOTAL.....		1	7	51	122	193	118	51	10		1	554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16...						1					1
90-95	3 9/16-3 12/16...			12	18	16	13	5	2			66
96-101	3 13/16-4	1	16	84	132	228	130	58	14	1		664
102-107	4 -4 3/16		9	41	123	195	131	41	17	2		559
108-113	4 4/16-4 7/16...			8	18	21	25	5	5			82
114-119	4 8/16-4 11/16...				1	2		2				5
120-125	4 12/16-4 15/16...											
TOTAL.....		1	25	145	292	462	300	111	38	3		1377

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16...											24
90-95	3 9/16-3 12/16...			4	7	5	6	1	1			475
96-101	3 13/16-4	2	12	51	131	152	92	24	9	2		1005
102-107	4 -4 3/16	1	24	83	237	335	205	102	18			286
108-113	4 4/16-4 7/16...		5	30	70	84	61	28	7		1	22
114-119	4 8/16-4 11/16...			1	4	5	5	5	2			
120-125	4 12/16-4 15/16...											
TOTAL.....		3	41	169	449	581	369	160	37	2	1	1812



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		PLANAR ARCH HEIGHT										TOTAL
		mm. 11-14	15-18	19-22	23-26	27-30	31-34	35-38	39-42	43-46	47-50	
		in. 7/16-9/16	9/16-11/16	12/16-14/16	15/16-1	1 1/16-1 3/16	1 4/16-1 5/16	1 6/16-1 8/16	1 9/16-1 11/16	1 11/16-1 13/16	1 14/16-2	
84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
90-95	3 9/16-3 12/16..	.....	1	1	3	1	2	.....	.....	.....	.....	178
96-101	3 13/16-4.....	.....	3	20	53	54	33	11	3	1	.....	619
102-107	4 -4 3/16.....	1	13	71	154	195	120	53	8	4	.....	347
108-113	4 4/16-4 7/16..	2	12	22	81	114	84	29	3	.....	.....	46
114-119	4 8/16-4 11/16..	.....	1	3	9	11	15	5	1	.....	1	4
120-125	4 12/16-4 15/16	.....	.....	.....	1	1	1	1	.....	.....	.....	4
TOTAL.....		3	30	117	301	376	255	99	15	5	1	1202

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
90-95	3 9/16-3 12/16..	.....	.....	1	.....	.....	.....	1	.....	.....	.....	21
96-101	3 13/16-4.....	.....	1	3	5	6	5	1	.....	.....	.....	157
102-107	4 -4 3/16.....	.....	6	23	36	45	26	12	5	3	1	180
108-113	4 4/16-4 7/16..	1	9	16	40	52	44	14	4	.....	.....	58
114-119	4 8/16-4 11/16..	.....	1	4	14	13	20	4	2	.....	.....	6
120-125	4 12/16-4 15/16	.....	.....	1	1	3	1	.....	.....	.....	.....	424
TOTAL.....		1	17	48	96	119	96	32	11	3	1	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
90-95	3 9/16-3 12/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9
96-101	3 13/16-4.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	38
102-107	4 -4 3/16.....	.....	.....	3	6	6	2	2	.....	.....	.....	24
108-113	4 4/16-4 7/16..	.....	.....	6	12	9	6	3	2	.....	.....	6
114-119	4 8/16-4 11/16..	.....	2	3	8	6	4	.....	.....	1	.....	88
120-125	4 12/16-4 15/16	.....	.....	.....	1	4	.....	1	.....	.....	.....	.....
TOTAL.....		.....	2	12	27	26	12	6	2	1	.....	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
90-95	3 9/16-3 12/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
96-101	3 13/16-4.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	7
102-107	4 -4 3/16.....	.....	.....	1	.....	1	1	.....	.....	.....	.....	1
108-113	4 4/16-4 7/16..	.....	.....	.....	1	.....	.....	1	.....	.....	.....	13
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	.....	.....	.....	4	3	.....	.....
120-125	4 12/16-4 15/16	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....
TOTAL.....		.....	.....	1	1	2	1	1	4	3	.....	13

# DORSAL ARCH HEIGHT

GENERAL - This dimension was measured as illustrated in the accompanying photograph (Fig. 84). It represents the height from the ground to the dorsal surface of the foot where it joins the leg, and constitutes a second measurement of the arch. 98% of the white population is included within a range of 15/16 in. The Negro measurements tend to be smaller than those of the white subjects (Fig. 85, Table 41).

CORRELATIONS - Dorsal arch height correlates poorly, if at all, with foot length and with foot breadth. There is a pronounced scatter of the measurements such that a given foot length and/or breadth may be associated with a wide variety of arch heights (Table 42).



Figure 84  
Dorsal Arch Height

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be +0.3 mm., and the absolute mean difference without regard to sign was 2.2 mm. The range of differences is shown by the continuous line on Fig. 86.

DIFFERENCES BETWEEN RIGHT AND LEFT FOOT - The mean right arch height was 0.87 mm. larger than the mean left arch height. The distribution of the differences between the measurements of the right and left foot are shown by the broken line in Fig. 86, where they are compared with the duplicate measurements on the same foot.

TABLE 41

## DORSAL ARCH HEIGHT

No. Subjects	WHITE 5575		NEGRO 1200	
	mm.	in.	mm.	in.
Mean.....	78.2	3 1/16	74.8	2 15/16
100% range.....	59-100	2 5/16 - 3 15/16	60-90	2 6/16 - 3 9/16
98% range.....	67-91	2 10/16 - 3 9/16	64-86	2 8/16 - 3 6/16
95% range.....	69-88	2 12/16 - 3 7/16	66-84	2 10/16 - 3 5/16

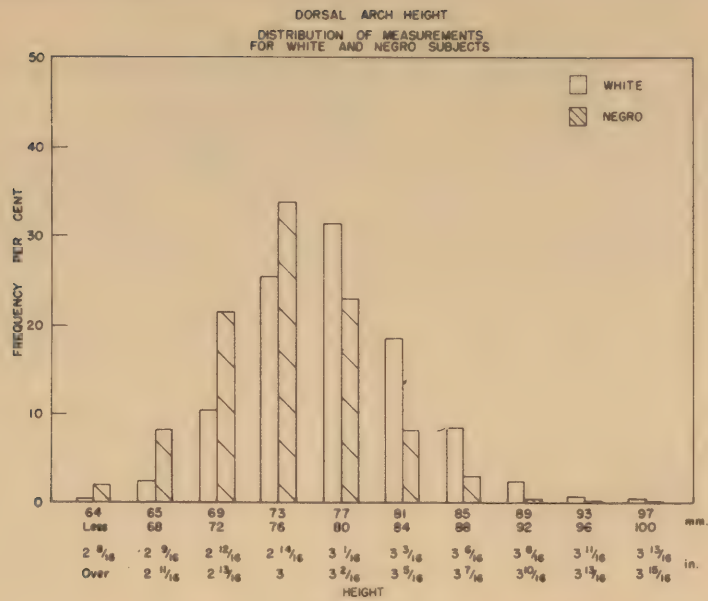


Figure 85

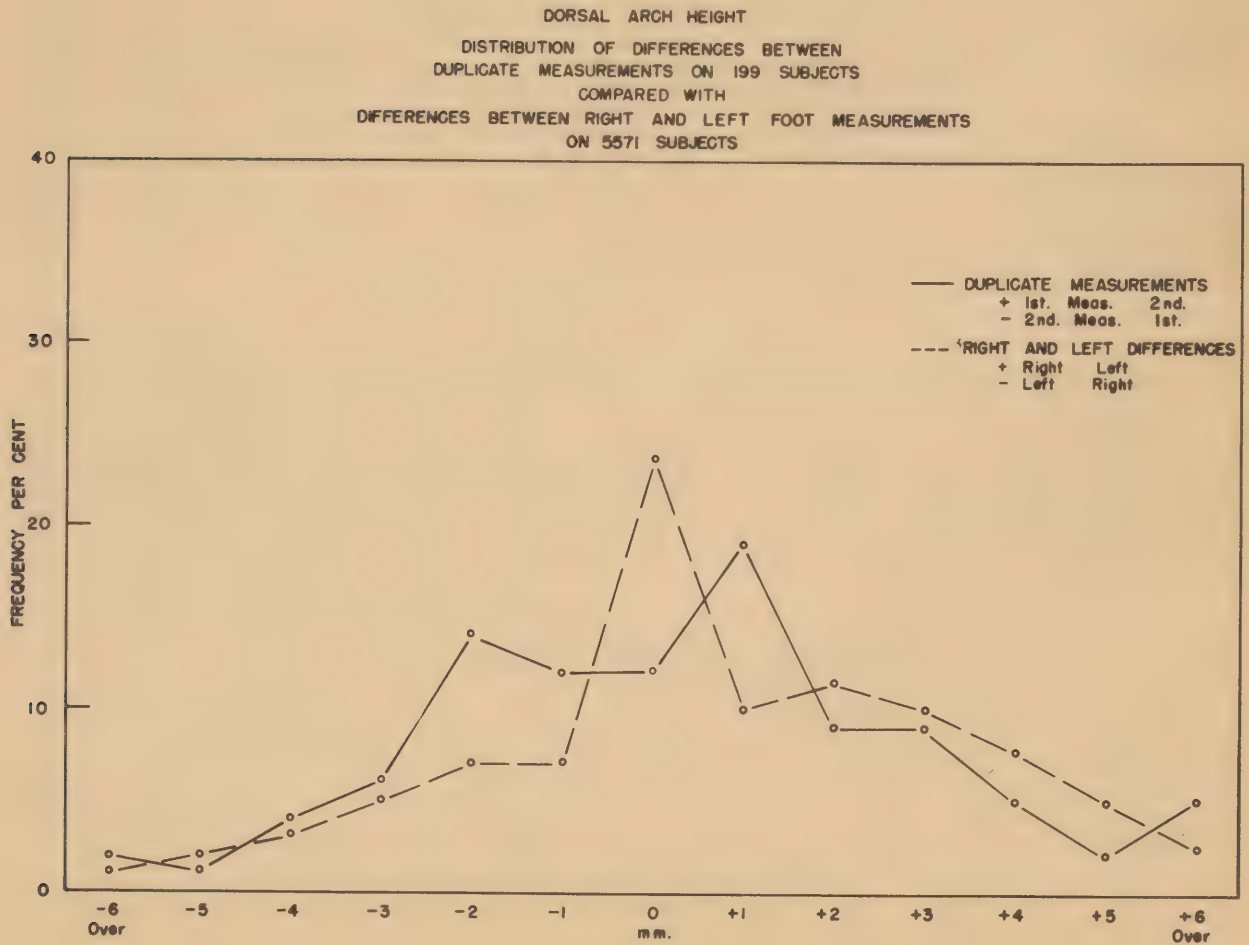


Figure 86



TABLE 42  
CORRELATION BETWEEN DORSAL ARCH HEIGHT  
AND LENGTH AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		DORSAL ARCH HEIGHT										TOTAL	
		mm.	64 & Less	65-68	69-72	73-76	77-80	81-84	85-88	89-92	93-96		97-100
		in.	2 8/16 & Less	2 9/16-2 11/16	2 12/16-2 13/16	2 19/16-3	3 1/16-3 2/16	3 3/16-3 5/16	3 6/16-3 7/16	3 8/16-3 10/16	3 11/16-3 13/16		3 13/16-3 15/16
mm.	in.												
84-89	3 5/16-3 8/16												
90-95	3 9/16-3 12/16			1	1								2
96-101	3 13/16-4			1	1		1						3
102-107	4 - 4 3/16			1									1
108-113	4 4/16-4 7/16												
114-119	4 8/16-4 11/16												
120-125	4 12/16-4 15/16												
TOTAL				3	2		1						6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16	.....	1	1	1	2	.....	1	.....	.....	.....	.....	6
90-95	3 9/16-3 12/16	.....	1	1	3	8	.....	4	1	.....	.....	.....	27
96-101	3 13/16-4	.....	.....	1	10	18	9	5	2	.....	.....	.....	45
102-107	4 - 4 3/16	.....	.....	1	1	1	3	3	.....	.....	.....	.....	9
108-113	4 4/16-4 7/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
114-119	4 8/16-4 11/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
120-125	4 12/16-4 15/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL	.....	.....	2	4	15	29	21	13	3	.....	.....	.....	87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16	.....	.....	1	.....	1	.....	.....	.....	.....	.....	.....	2
90-95	3 9/16-3 12/16	.....	3	12	13	25	22	8	1	.....	.....	.....	84
96-101	3 13/16-4	.....	1	18	55	98	96	44	12	2	.....	.....	326
102-107	4 - 4 3/16	.....	2	2	15	38	44	17	8	2	.....	.....	128
108-113	4 4/16-4 7/16	.....	.....	.....	4	1	1	3	2	.....	.....	.....	11
114-119	4 8/16-4 11/16	.....	.....	.....	.....	.....	2	1	.....	.....	.....	.....	3
120-125	4 12/16-4 15/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL	.....	.....	6	32	88	162	166	73	23	4	.....	.....	554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	1
90-95	3 9/16-3 12/16	.....	.....	5	10	22	19	6	3	1	.....	.....	66
96-101	3 13/16-4	.....	5	31	99	225	174	86	38	4	3	.....	665
102-107	4 - 4 3/16	.....	.....	12	59	146	193	94	41	11	3	.....	560
108-113	4 4/16-4 7/16	.....	.....	1	9	16	24	13	12	7	.....	1	83
114-119	4 8/16-4 11/16	.....	.....	.....	1	.....	1	1	1	.....	.....	.....	5
120-125	4 12/16-4 15/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL	.....	.....	5	49	178	409	412	200	95	24	6	2	1380

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16	.....	.....	5	9	6	3	1	.....	.....	.....	.....	24
96-101	3 13/16-4	.....	3	13	56	148	155	70	21	8	.....	1	475
102-107	4 - 4 3/16	.....	2	15	96	229	342	198	91	24	6	2	1005
108-113	4 4/16-4 7/16	.....	.....	3	21	61	92	64	35	6	4	.....	286
114-119	4 8/16-4 11/16	.....	.....	.....	1	4	4	2	8	3	.....	.....	22
120-125	4 12/16-4 15/16	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL	.....	.....	5	31	179	451	599	337	156	41	10	3	1812

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		DORSAL ARCH HEIGHT										TOTAL	
		mm.	64 & Less	65-68	69-72	73-76	77-80	81-84	85-88	89-92	93-96		97-100
		in.	2 8/16 & Less	2 9/16-2 11/16	2 12/16-2 13/16	2 19/16-3"	3 1/16-3 2/16	3 3/16-3 5/16	3 6/16-3 7/16	3 8/16-3 10/16	3 11/16-3 13/16		3 13/16-3 15/16
mm.	in.												
84-89	3 5/16-3 8/16.....												
90-95	3 9/16-3 12/16.....	1	1	2	2	1	1					8	
96-101	3 13/16-4 .....		1	19	43	55	40	14	6			178	
102-107	4 - 4 3/16.....	1	7	44	147	197	133	67	16	6	1	619	
108-113	4 4/16-4 7/16.....		2	12	64	123	90	45	9	2		347	
114-119	4 8/16-4 11/16.....			1	11	10	11	8	4	1		46	
120-125	4 12/16-4 15/16.....					1	2	1				4	
TOTAL.....		2	11	78	267	387	277	135	35	9	1	1202	

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16.....												2
90-95	3 9/16-3 12/16.....					1	1						21
96-101	3 13/16-4 .....				4	3	5	7	1	1			151
102-107	4 - 4 3/16.....			3	14	37	43	30	13	4	4	3	173
108-113	4 4/16-4 7/16.....			3	9	29	53	54	19	5	1		58
114-119	4 8/16-4 11/16.....				1	9	14	19	11	3	1		6
120-125	4 12/16-4 15/16.....					1	1	2	1	1			
TOTAL.....				6	28	80	117	112	45	14	6	3	411

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16.....												1
90-95	3 9/16-3 12/16.....												19
96-101	3 13/16-4 .....						1						38
102-107	4 - 4 3/16.....				1	3	6	5	3		1		24
108-113	4 4/16-4 7/16.....				2	4	15	7	6	4			6
114-119	4 8/16-4 11/16.....				1	2	10	3	6	2			
120-125	4 12/16-4 15/16.....							2	4				
TOTAL.....					4	9	32	17	19	6	1		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16.....												3
90-95	3 9/16-3 12/16.....												2
96-101	3 13/16-4 .....												7
102-107	4 - 4 3/16.....						1	2					1
108-113	4 4/16-4 7/16.....						1		1				
114-119	4 8/16-4 11/16.....					2	1	2		1		1	
120-125	4 12/16-4 15/16.....							1					
TOTAL.....						2	3	5	1	1		1	13

# BREADTH OF INSTEP

GENERAL - These dimensions were measured from a photograph of the sole as illustrated (Fig. 87). The breadth of the instep was measured in the plane of the junction of the foot and leg and includes the portion of the sole which curves upward in the hollow of the arch ( $x + y$ ). The proportion of the total breadth in contact with the ground is  $x/x + y$ ; it was estimated to the nearest 25 percent. 98% of the white population is included within a range of  $1 \frac{1}{16}$  in. for instep breadth, and the great majority have 50% or less of that breadth in contact with the ground (Fig. 88A). The Negro measurements tend to be larger than those of the white subjects, and the majority of the Negroes have 50% or more of the instep breadth in contact with the ground (Fig. 88 & 88A, Table 43).



Figure 87  
Breadth of Instep

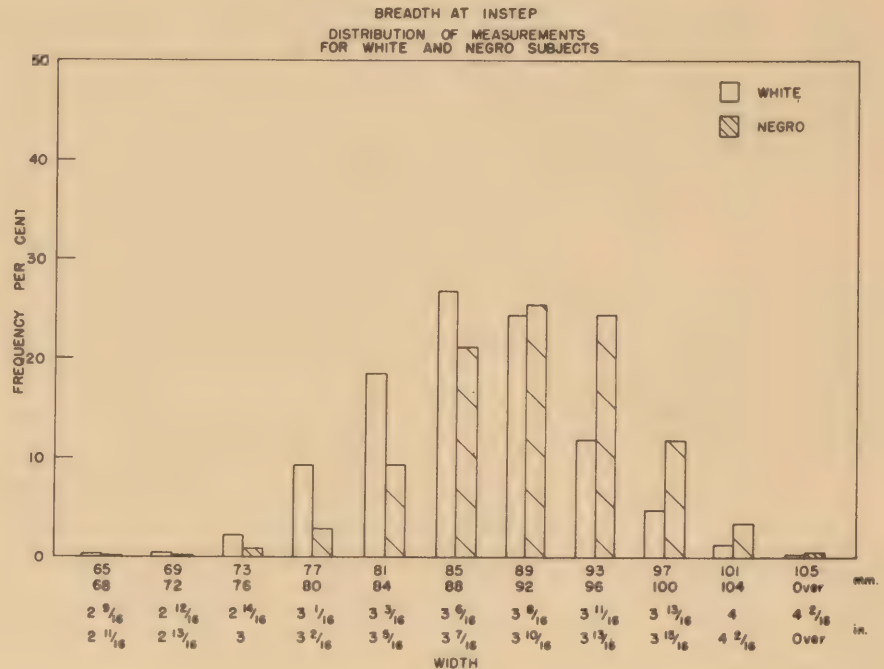


Figure 88

TABLE 43  
BREADTH OF INSTEP

	WHITE 5561		NEGRO 1200	
	mm.	in.	mm.	in.
Mean .....	87.7	$3 \frac{7}{16}$	91.2	$3 \frac{9}{16}$
100% range ....	66-110	$2 \frac{10}{16} - 4 \frac{5}{16}$	74-110	$2 \frac{15}{16} - 4 \frac{5}{16}$
98% range ....	74-101	$2 \frac{15}{16} - 4$	78-103	$3 \frac{1}{16} - 4 \frac{1}{16}$
95% range ....	76-98	$3 - 3 \frac{14}{16}$	80-101	$3 \frac{2}{16} - 4$



CORRELATIONS - Both instep breadth and the proportion of the breadth in contact with the ground correlate in a measure with foot breadth, although poorly, if at all, with foot length. There is a pronounced scatter of the measurements such that a given foot length and/or breadth may be associated with variety of instep breadths. (Tables 44 & 45).

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements of instep breadth was found to be -0.2 mm., and the absolute mean difference without regard to sign was 1.7 mm. The range of differences is shown in Fig. 89. In 57% of the estimates of the proportion of the total breadth in contact with the ground, the duplicate estimates were identical, while in 41.5% they differed by one 25 percentile grouping.

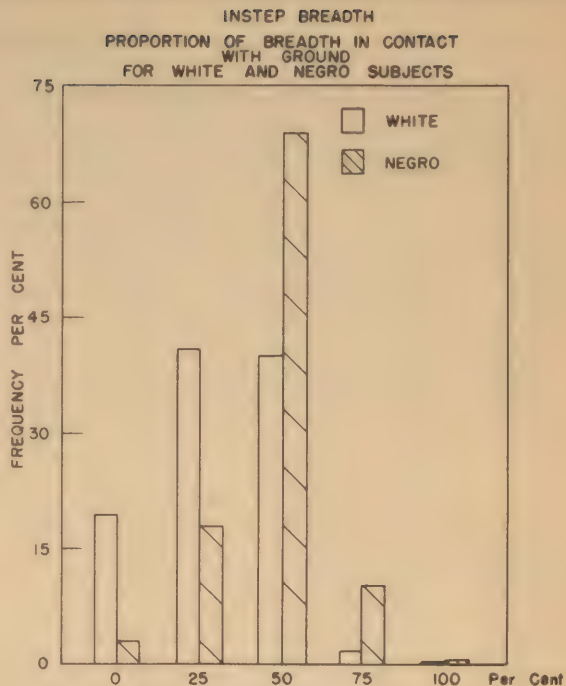


Figure 88A

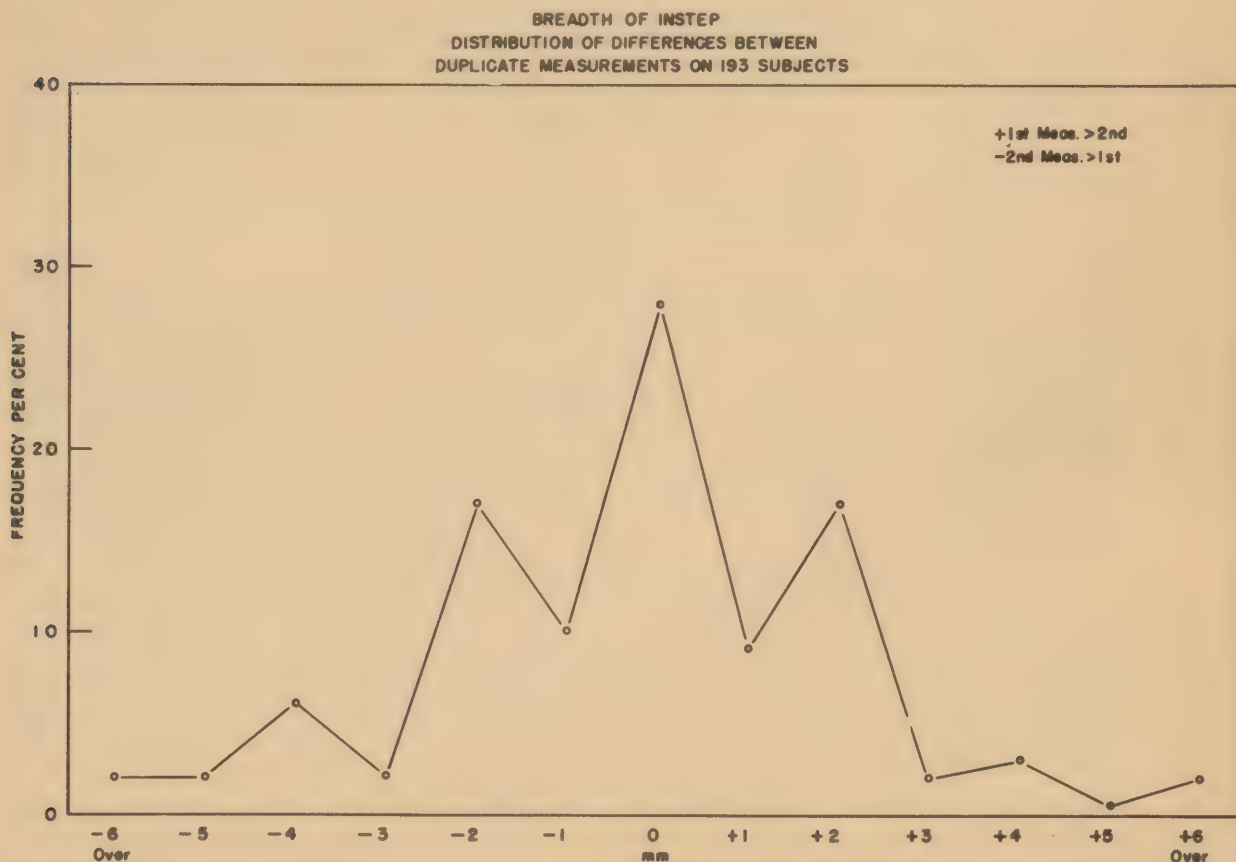


Figure 89

TABLE 44  
CORRELATION BETWEEN BREADTH AT INSTEP AND LENGTH  
AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		BREADTH AT INSTEP										TOTAL	
		mm. 65-68	69-72	73-76	77-80	81-84	85-88	89-92	93-96	97-100	101-104		105 - Over
		in. 2 9/16- 2 11/16	2 12/16- 2 13/16	2 14/16- 3"	2 1/16-3 2 2/16	3 3/16-3 3 5/16	3 6/16-3 3 7/16	3 8/16-3 10/16	3 11/16-3 13/16	3 13/16- 15/16	4" 4 2/16		4 2/16 & Over
mm.	in.												
84-89	3 5/16-3 8/16..												
90-95	3 9/16-3 12/16..				1	1						2	
96-101	3 13/16-4".....				1	2						3	
102-107	4"-4 3/16.....						1					1	
108-113	4 4/16-4 7/16..												
114-119	4 8/16-4 11/16..												
120-125	4 12/16-4 15/16..												
TOTAL.....					2	3	1					6	

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16..			5	1								6
90-95	3 9/16-3 12/16..		1	3	<u>10</u>	6	5	2					27
96-101	3 13/16-4".....	2	2	7	<u>16</u>	15	3						<u>45</u>
102-107	4"-4 3/16.....			2		1	1	5					9
108-113	4 4/16-4 7/16..												
114-119	4 8/16-4 11/16..												
120-125	4 12/16-4 15/16..												
TOTAL.....		2	3	17	<u>27</u>	22	9	7					87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16..				2								2
90-95	3 9/16-3 12/16..		1	18	<u>32</u>	23	6	3		1			84
96-101	3 13/16-4".....	1	4	18	<u>90</u>	<u>106</u>	73	32	1			1	<u>326</u>
102-107	4"-4 3/16.....		1	4	14	<u>29</u>	<u>48</u>	26	6				<u>128</u>
108-113	4 4/16-4 7/16..			1	1	2	<u>3</u>	1	2	1			11
114-119	4 8/16-4 11/16..				2				1				3
120-125	4 12/16-4 15/16..												
TOTAL.....		1	6	41	141	<u>160</u>	130	62	10	2		1	554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16..						1						1
90-95	3 9/16-3 12/16..		1	11	<u>26</u>	18	8	2					66
96-101	3 13/16-4".....	1	3	34	<u>122</u>	<u>222</u>	209	61	9	2	1		<u>664</u>
102-107	4"-4 3/16.....			6	35	<u>121</u>	<u>204</u>	152	34	7			<u>559</u>
108-113	4 4/16-4 7/16..			1	6	8	<u>15</u>	<u>30</u>	16	7			83
114-119	4 8/16-4 11/16..							<u>1</u>	<u>2</u>	1	1		5
120-125	4 12/16-4 15/16..												
TOTAL.....		1	4	52	189	369	<u>437</u>	246	61	17	2		1378

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16..												
90-95	3 9/16-3 12/16..			2	6	<u>12</u>	4						24
96-101	3 13/16-4".....		1	6	68	<u>146</u>	<u>162</u>	73	14	2			472
102-107	4"-4 3/16.....		1	3	47	156	<u>319</u>	<u>346</u>	108	21			<u>1001</u>
108-113	4 4/16-4 7/16..				2	12	68	<u>93</u>	73	32	5		<u>285</u>
114-119	4 8/16-4 11/16..					1	2	6	3	6	4		22
120-125	4 12/16-4 15/16..												
TOTAL.....			2	11	123	327	<u>555</u>	518	198	61	9		1804

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		BREADTH AT INSTEP											TOTAL
		mm. 65-68	69-72	73-76	77-80	81-84	85-88	89-92	93-96	97-100	101-104	105- Over	
		in. 2 9/16- 2 11/16	2 12/16- 2 13/16	2 14/16- 3"	3 1/16- 3 2/16	3 3/16- 3 5/16	3 6/16- 3 7/16	3 8/16- 3 10/16	3 11/16- 3 13/16	3 13/16- 3 15/16	4"- 4 2/16	4 2/16 & Over	
mm.	in.												
84-89	3 5/16-3 8/16..												8
90-95	3 9/16-3 12/16..		1		2	3	2						178
96-101	3 13/16-4".....			5	19	45	54	41	14				618
102-107	4"-4 3/16.....	1	1		12	70	187	229	93	24	1		346
108-113	4 4/16-4 7/16..				1	15	48	102	111	59	10		46
114-119	4 8/16-4 11/16..					1	2	12	15	12	3	1	4
120-125	4 12/16-4 15/16..						1		1		2		
TOTAL.....		1	2	5	34	134	294	384	234	95	16	1	1200

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..												2
90-95	3 9/16-3 12/16..					1			1				21
96-101	3 13/16-4".....				2	4	5	7	3				156
102-107	4"-4 3/16.....				3	8	39	56	41	7	2		179
108-113	4 4/16-4 7/16..			1		4	17	53	54	35	15		58
114-119	4 8/16-4 11/16..						1	5	23	19	10		6
120-125	4 12/16-4 15/16..								3	1	2		
TOTAL.....				1	5	17	62	121	125	62	29		422

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16..												1
90-95	3 9/16-3 12/16..									1			19
96-101	3 13/16-4".....										1		38
102-107	4"-4 3/16.....					1	3	8	6				24
108-113	4 4/16-4 7/16..					1	1	8	22	3	3		6
114-119	4 8/16-4 11/16..							1	13	3	4	3	
120-125	4 12/16-4 15/16..									1	4	1	
TOTAL.....						2	4	17	41	8	12	4	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..												3
90-95	3 9/16-3 12/16..												2
96-101	3 13/16-4".....												7
102-107	4"-4 3/16.....							1	1	1			1
108-113	4 4/16-4 7/16..								2				
114-119	4 8/16-4 11/16..	3								2		2	
120-125	4 12/16-4 15/16..										1		
TOTAL.....		3						1	3	3	1	2	13



TABLE 45  
CORRELATION BETWEEN PROPORTION OF INSTEP BREADTH IN CONTACT WITH GROUND  
AND LENGTH AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH	Percent	PROPORTION OF INSTEP BREADTH IN CONTACT WITH GROUND					TOTAL
		0	25	50	75	100	
mm.	in.						
84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16.	1	.....	1	.....	.....	2
96-101	3 13/16-4.....	.....	2	1	.....	.....	3
102-107	4-4 3/16.....	.....	.....	1	.....	.....	1
108-113	4 4/16-4 7/16..	.....	.....	.....	.....	.....	.....
114-119	4 8/16-4 11/16.	.....	.....	.....	.....	.....	.....
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....
TOTAL.....		1	2	3	.....	.....	6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16..	2	1	3	.....	.....	6
90-95	3 9/16-3 12/16.	6	14	6	.....	.....	26
96-101	3 13/16-4.....	15	14	16	.....	.....	45
102-107	4-4 3/16.....	2	5	2	.....	.....	9
108-113	4 4/16-4 7/16..	.....	.....	.....	.....	.....	.....
114-119	4 8/16-4 11/16.	.....	.....	.....	.....	.....	.....
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....
TOTAL.....		25	34	27	.....	.....	86

LENGTH GROUP 245 to 254 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16..	.....	2	.....	.....	.....	2
90-95	3 9/16-3 12/16.	29	28	18	7	.....	82
96-101	3 13/16-4.....	70	138	113	4	.....	325
102-107	4-4 3/16.....	22	51	52	3	.....	128
108-113	4 4/16-4 7/16..	3	5	3	.....	.....	11
114-119	4 8/16-4 11/16.	1	2	.....	.....	.....	3
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....
TOTAL.....		125	226	186	14	.....	551

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16..	.....	.....	1	.....	.....	1
90-95	3 9/16-3 12/16.	17	28	20	1	.....	66
96-101	3 13/16-4.....	156	270	227	10	.....	663
102-107	4-4 3/16.....	93	237	220	8	.....	558
108-113	4 4/16-4 7/16..	16	23	42	2	.....	83
114-119	4 8/16-4 11/16.	.....	4	1	.....	.....	5
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....
TOTAL.....		282	562	511	21	.....	1376

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16.	15	7	2	.....	.....	24
96-101	3 13/16-4.....	109	202	156	5	.....	472
102-107	4-4 3/16.....	179	403	401	20	.....	1003
108-113	4 4/16-4 7/16..	31	95	153	7	.....	286
114-119	4 8/16-4 11/16.	3	7	12	.....	.....	22
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....
TOTAL.....		337	714	724	32	.....	1807

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH	Percent	PROPORTION OF INSTEP BREADTH IN CONTACT WITH GROUND					TOTAL
		0	25	50	75	100	
mm.	in.						
84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16.	2	2	3	1	.....	8
96-101	3 13/16-4.....	60	71	45	2	.....	178
102-107	4-4 3/16.....	124	242	235	16	1	618
108-113	4 4/16-4 7/16..	54	122	164	7	.....	347
114-119	4 8/16-4 11/16.	3	14	28	1	.....	46
120-125	4 12/16-4 15/16.	2	.....	2	.....	.....	4
TOTAL.....		245	451	477	27	1	1201

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16.	1	1	.....	.....	.....	2
96-101	3 13/16-4.....	6	8	7	.....	.....	21
102-107	4-4 3/16.....	36	62	52	7	.....	157
108-113	4 4/16-4 7/16..	29	63	80	7	.....	179
114-119	4 8/16-4 11/16.	5	16	35	2	.....	58
120-125	4 12/16-4 15/16.	1	3	2	.....	.....	6
TOTAL.....		78	153	176	16	.....	423

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16.	.....	.....	.....	.....	.....	.....
96-101	3 13/16-4.....	1	.....	.....	.....	.....	1
102-107	4-4 3/16.....	3	6	9	.....	.....	18
108-113	4 4/16-4 7/16..	4	15	17	2	.....	38
114-119	4 8/16-4 11/16.	1	1	21	1	.....	24
120-125	4 12/16-4 15/16.	.....	6	.....	.....	.....	6
TOTAL.....		9	28	47	3	.....	87

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16.	.....	.....	.....	.....	.....	.....
96-101	3 13/16-4.....	.....	.....	.....	.....	.....	.....
102-107	4-4 3/16.....	1	1	1	.....	.....	3
108-113	4 4/16-4 7/16..	1	.....	1	.....	.....	2
114-119	4 8/16-4 11/16.	1	2	4	.....	.....	7
120-125	4 12/16-4 15/16.	.....	.....	1	.....	.....	1
TOTAL.....		3	3	7	.....	.....	13

# INSTEP GIRTH

GENERAL - This dimension was measured as illustrated in the accompanying photograph (Fig. 90). The plane in which this measurement was taken was that of the junction of the foot and leg; however, as the photograph shows, slippage of the tape below the reference mark occurred not infrequently. 98% of the white population is included within a range of 2 1/16 in. The Negro measurements tend to be larger than those of the white subjects (Fig. 91, Table 46).

CORRELATIONS - Instep girth correlates moderately well with both length and breadth of the foot. There is a pronounced scatter of the measurements however, such that a given foot length and/or breadth may be associated with a wide variety of instep girths (Table 47).



DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be -0.7 mm., and the absolute mean difference without regard to sign was 3.9 mm. The difficulty encountered in accurately placing the measuring tape led to the wide scatter of differences between duplicate measurements seen in Fig. 92.

Figure 90 - Instep Girth

Table 46  
Instep Girth

No. Subjects	WHITE 5574		NEGRO 1200	
	mm.	in.	mm.	in.
Mean.....	258.3	10 3/16	260.6	10 4/16
100% range.....	218-305	8 9/16 - 12	223-308	8 13/16 - 12 2/16
98% " .....	233-286	9 3/16 - 11 4/16	235-290	9 4/16 - 11 7/16
95% " .....	237-281	9 5/16 - 11 1/16	238-285	9 6/16 - 11 4/16



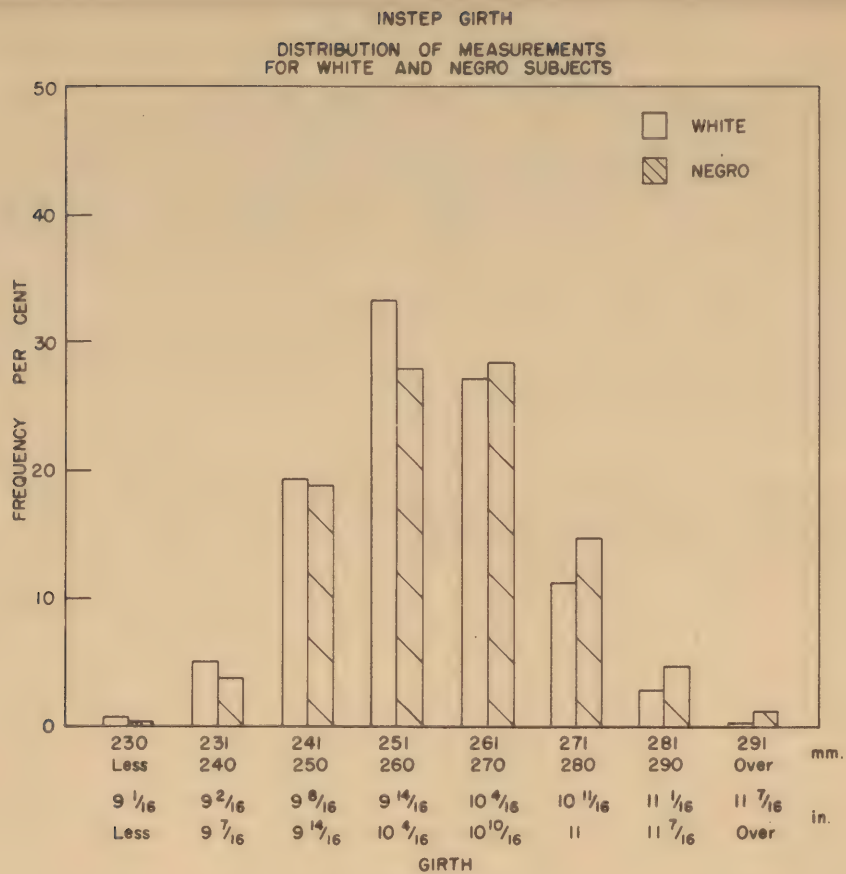


Figure 91

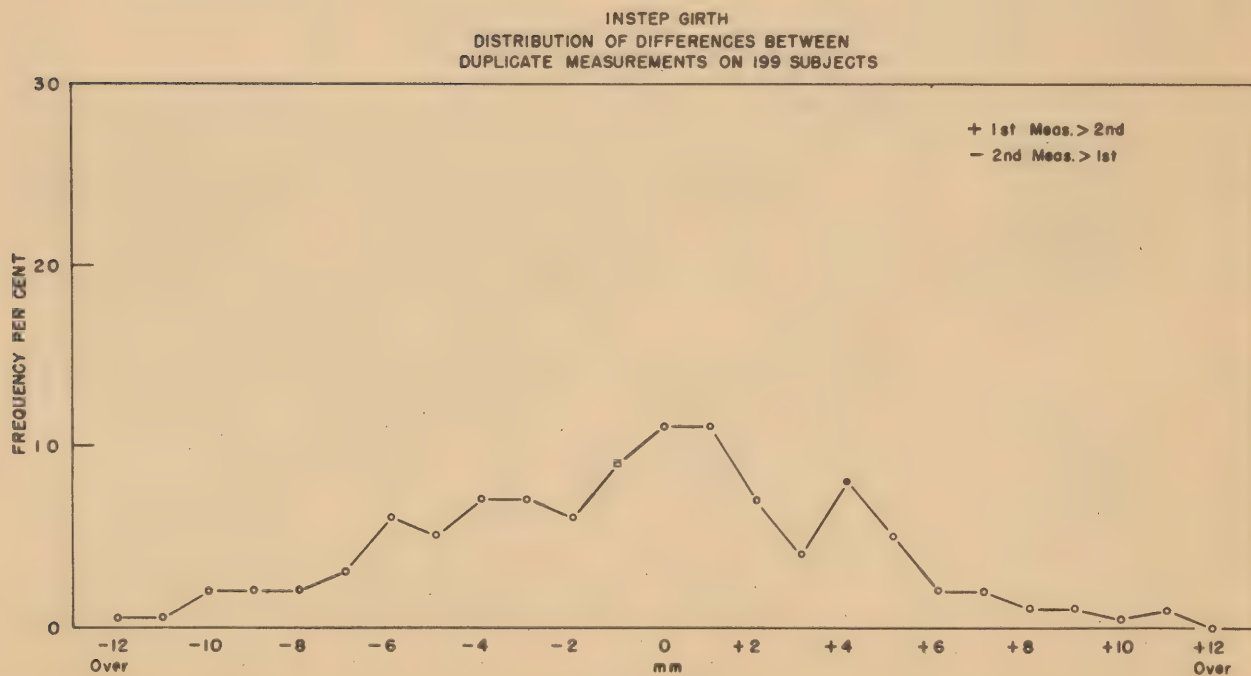


Figure 92

TABLE 47  
CORRELATION BETWEEN INSTEP GIRTH AND LENGTH  
AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		INSTEP GIRTH								TOTAL
		mm. 230-Less	231-240	241-250	251-260	261-270	271-280	281-290	291-Over	
		in. 2 1/16 & Less	9 2/16-9 7/16	9 8/16-9 14/16	9 14/16-10 4/16	10 4/16-10 10/16	10 10/16-11	11 1/16-11 7/16	11 7/16 & Over	
mm.	in.									
84-89	3 5/16-3 8/16.									
90-95	3 9/16-3 12/16.			2						2
96-101	3 13/16-4.....		1	1	1					3
102-107	4-4 3/16.....				1					1
108-113	4 4/16-4 7/16.									
114-119	4 8/16-4 11/16.									
120-125	4 12/16-4 15/16.									
TOTAL.....			1	3	2					6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16.	5	1							6
90-95	3 9/16-3 12/16.	1	9	12	3	2				27
96-101	3 13/16-4.....	5	12	<u>22</u>	6					<u>45</u>
102-107	4-4 3/16.....		2	<u>3</u>	1	2	1			9
108-113	4 4/16-4 7/16.									
114-119	4 8/16-4 11/16.									
120-125	4 12/16-4 15/16.									
TOTAL.....		11	24	<u>37</u>	10	4	1			87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16.	1		1						2
90-95	3 9/16-3 12/16.	16	26	<u>33</u>	9					84
96-101	3 13/16-4.....	7	68	<u>140</u>	98	13				<u>326</u>
102-107	4-4 3/16.....		5	<u>38</u>	<u>59</u>	25	1			<u>128</u>
108-113	4 4/16-4 7/16.		1	2	4	2	2			11
114-119	4 8/16-4 11/16.				2		1			3
120-125	4 12/16-4 15/16.									
TOTAL.....		24	100	<u>214</u>	172	40	4			554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16.				1					1
90-95	3 9/16-3 12/16.	2	18	<u>31</u>	14	1				66
96-101	3 13/16-4.....	1	80	<u>288</u>	240	52	3	1		<u>665</u>
102-107	4-4 3/16.....	1	9	<u>110</u>	<u>269</u>	149	20	2		<u>560</u>
108-113	4 4/16-4 7/16.		1	6	<u>27</u>	<u>36</u>	11	1	1	83
114-119	4 8/16-4 11/16.					<u>1</u>	3	1		5
120-125	4 12/16-4 15/16.									
TOTAL.....		4	108	435	<u>551</u>	239	37	5	1	1380

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16.									
90-95	3 9/16-3 12/16.	1	2	15	5	1				24
96-101	3 13/16-4.....		33	<u>151</u>	212	70	9			475
102-107	4-4 3/16.....	1	6	<u>122</u>	<u>418</u>	373	82	3		<u>1005</u>
108-113	4 4/16-4 7/16.	1	1	6	<u>62</u>	<u>126</u>	76	14		<u>286</u>
114-119	4 8/16-4 11/16.			3	3	3	7	5	1	22
120-125	4 12/16-4 15/16.									
TOTAL.....		3	42	297	<u>700</u>	573	174	22	1	1812

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		INSTEP GIRTH								TOTAL
		mm. 230-Less	231-240	241-250	251-260	261-270	271-280	281-290	291-Over	
		in. 2 1/16 & Less	9 2/16-9 7/16	9 8/16-9 14/16	9 14/16-10 4/16	10 4/16-10 10/16	10 10/16-11	11 1/16-11 7/16	11 7/16 & Over	
mm.	in.									
84-89	3 5/16-3 8/16.									
90-95	3 9/16-3 12/16.		2	4	1		1			8
96-101	3 13/16-4.		6	39	83	38	12			178
102-107	4-4 3/16.		3	37	219	276	75	9		619
108-113	4 4/16-4 7/16.		1	5	47	147	115	31		346
114-119	4 8/16-4 11/16.					15	21	9	1	46
120-125	4 12/16-4 15/16.					1	2	1		4
TOTAL.....			12	85	350	477	226	50	1	1201

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16.									
90-95	3 9/16-3 12/16.				1		1			2
96-101	3 13/16-4.			2	9	8	2			21
102-107	4-4 3/16.			5	35	77	33	7		157
108-113	4 4/16-4 7/16.				10	63	77	28	2	180
114-119	4 8/16-4 11/16.				1	5	28	23	1	58
120-125	4 12/16-4 15/16.						3	2	1	6
TOTAL.....				7	56	153	144	60	4	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16.									
90-95	3 9/16-3 12/16.									
96-101	3 13/16-4.				1					1
102-107	4-4 3/16.				2	10	3	4		19
108-113	4 4/16-4 7/16.					14	16	6	2	38
114-119	4 8/16-4 11/16.						11	10	3	24
120-125	4 12/16-4 15/16.						1	3	2	6
TOTAL.....					3	24	31	23	7	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16.									
90-95	3 9/16-3 12/16.									
96-101	3 13/16-4.									
102-107	4-4 3/16.					1	2			3
108-113	4 4/16-4 7/16.						2			2
114-119	4 8/16-4 11/16.						4		3	7
120-125	4 12/16-4 15/16.							1		1
TOTAL.....						1	8	1	3	13



GENERAL - This dimension was measured from a photograph of the sole as illustrated (Fig. 93). 98% of the white population is included within a range of 10/16 in. The Negro measurements tend to be larger than those of the white subjects (Fig. 94, Table 48).



Figure 93  
Heel Breadth

CORRELATIONS - Heel breadth correlates to a moderate degree with both length and breadth of the foot. There is a pronounced scatter of the measurements such that a given length and/or breadth of the foot may be associated with a wide variety of heel breadths (Table 49).

DUPLICATE MEASUREMENTS - The algebraic mean of the difference between duplicate measurements was found to be +0.2 mm., and the absolute mean difference without regards to sign was 1.4 mm. The range of differences is shown in Fig. 95.

TABLE 48

## HEEL BREADTH

No. Subjects	WHITE 5561		NEGRO 1197	
	mm.	in.	mm.	in.
Mean .....	69.6	2 12/16	72.6	2 14/16
100% range.....	49-87	1 15/16 - 3 7/16	60-86	2 6/16 - 3 6/16
98% range.....	62-78	2 7/16 - 3 1/16	64-81	2 8/16 - 3 3/16
95% range.....	62-77	2 7/16 - 3 1/16	65-80	2 9/16 - 3 2/16

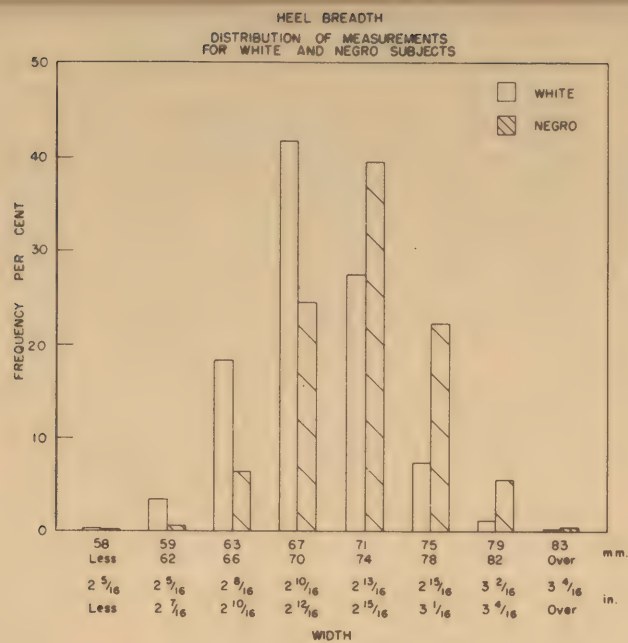


Figure 94

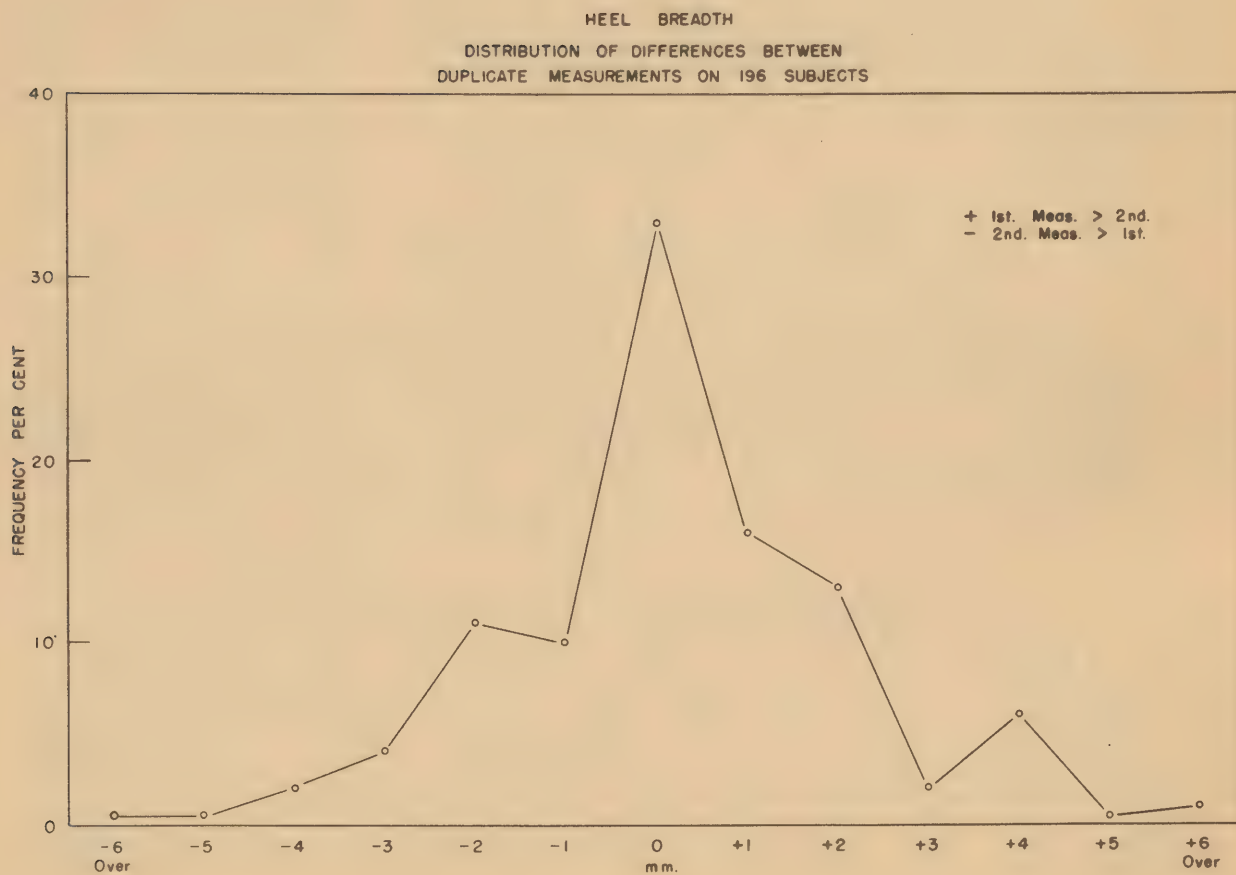


Figure 95

TABLE 49  
CORRELATION BETWEEN HEEL BREADTH AND LENGTH  
AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		HEEL BREADTH							TOTAL
		mm. 58- Less	59-62	63-66	67-70	71-74	75-78	79-82	
		in. 2 3/16 & Less	2 5/16- 2 7/16	2 8/16- 2 10/16	2 10/16 2 12/16	2 13/16 2 15/16	2 15/16 3 1/16	3 2/16 3 4/16	
84-89	3 5/16-3 8/16..								
90-95	3 9/16-3 12/16.		1		1				2
96-101	3 13/16-4.....			1	2				3
102-107	4 -4 3/16.....				1				1
108-113	4 4/16-4 7/16..								
114-119	4 8/16-4 11/16.								
120-125	4 12/16-4 15/16								
TOTAL.....			1	1	4				6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16..		6						6
90-95	3 9/16-3 12/16.		1	16	8	2			27
96-101	3 13/16-4.....		10	23	11	1			45
102-107	4 -4 3/16.....			3	2	4			9
108-113	4 4/16-4 7/16..								
114-119	4 8/16-4 11/16.								
120-125	4 12/16-4 15/16								
TOTAL.....			17	42	21	7			87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16..		1	1					2
90-95	3 9/16-3 12/16.	1	24	40	17	2			84
96-101	3 13/16-4.....	1	27	132	131	31	3	1	326
102-107	4 -4 3/16.....		2	29	73	24			128
108-113	4 4/16-4 7/16..			4	3	2	2		11
114-119	4 8/16-4 11/16.		1		1		1		3
120-125	4 12/16-4 15/16								
TOTAL.....		2	55	206	225	59	6		554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16..				1				1
90-95	3 9/16-3 12/16.		10	34	21				65
96-101	3 13/16-4.....	1	41	235	303	80	4		664
102-107	4 -4 3/16.....		7	86	303	135	27	1	559
108-113	4 4/16-4 7/16..		2	7	36	30	8		83
114-119	4 8/16-4 11/16.					4	1		5
120-125	4 12/16-4 15/16								
TOTAL.....		1	60	362	664	249	40	1	1377

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16..								
90-95	3 9/16-3 12/16.		5	12	5	2			24
96-101	3 13/16-4.....	1	31	126	219	86	9		473
102-107	4 -4 3/16.....	1	10	136	481	322	50	1	1002
108-113	4 4/16-4 7/16..			8	89	135	46		284
114-119	4 8/16-4 11/16.			1	4	9	2		22
120-125	4 12/16-4 15/16								
TOTAL.....		2	46	283	708	554	107	14	1805



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		HEEL BREADTH								TOTAL
		mm. 58- Less	59-62	63-66	67-70	71-74	75-78	79-82	83-Over	
		in. 2 3/16 & Less	2 5/16- 2 7/16	2 8/16- 2 10/16	2 10/16 2 12/16	2 13/16 2 15/16	2 15/16 3 1/16	3 2/16 3 4/16	3 4/16 & Over	
84-89	3 5/16-3 8/16..									
90-95	3 9/16-3 12/16..		2	2	2	2				8
96-101	3 13/16-4.....		11	29	94	39	4	1		178
102-107	4 -4 3/16.....		1	61	<u>281</u>	224	49	2	1	<u>619</u>
108-113	4 4/16-4 7/16..		1	13	<u>86</u>	<u>153</u>	75	18		<u>346</u>
114-119	4 8/16-4 11/16..				4	<u>20</u>	19	3		46
120-125	4 12/16-4 15/16					<u>1</u>	2	1		4
TOTAL.....			15	105	<u>467</u>	439	149	25	1	1201

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..									
90-95	3 9/16-3 12/16..				2					2
96-101	3 13/16-4.....			4	<u>10</u>	7				21
102-107	4 -4 3/16.....			9	<u>72</u>	61	15			157
108-113	4 4/16-4 7/16..			5	<u>41</u>	86	39	8		<u>179</u>
114-119	4 8/16-4 11/16..			2	2	<u>25</u>	21	5	3	<u>58</u>
120-125	4 12/16-4 15/16					<u>3</u>		3		6
TOTAL.....				20	127	<u>182</u>	75	16	3	423

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16..									
90-95	3 9/16-3 12/16..									
96-101	3 13/16-4.....				1					1
102-107	4 -4 3/16.....				5	<u>10</u>	3	1		19
108-113	4 4/16-4 7/16..			1	7	<u>17</u>	11	1	1	<u>32</u>
114-119	4 8/16-4 11/16..				1	<u>7</u>	<u>10</u>	5	1	<u>24</u>
120-125	4 12/16-4 15/16					1	<u>2</u>	3		6
TOTAL.....				1	14	<u>35</u>	26	10	2	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..									
90-95	3 9/16-3 12/16..									
96-101	3 13/16-4.....									
102-107	4 -4 3/16.....				2	1				3
108-113	4 4/16-4 7/16..					2				2
114-119	4 8/16-4 11/16..					3	2	2		7
120-125	4 12/16-4 15/16							1		1
TOTAL.....					2	6	2	3		13

GENERAL - This dimension was measured as illustrated in the accompanying photograph (Fig. 96). A graded series of aluminum templates was approximated to the posterior curvature of the heel, in the sagittal plane, for description of the complex curvilinear shapes in the region of the heel and the insertion of the Achilles tendon. Fig. 97 shows the variety of shapes encountered among both the white and Negro subjects, while in Fig. 98 may be seen the composite shape limits of selected percentages of the population. The calcaneal protuberances of the Negroes and white subjects are seen to be of approximately the same shape. The popular belief that the calcaneal protuberance is greater among Negroes than among whites appears to be illusory and is to be attributed to the more marked anterior indentation of the curvature superior to the calcis in the former group.



Figure 96  
Posterior Heel Contour

It is noted in the section on clinical examinations that irregularities of heel shape with local prominences and bulges for the most part lateral to the sagittal plane, are far more frequently encountered among whites than among Negroes. On the other hand, the variety of basic shapes is greater among Negroes. It was the consensus of the medical officers who examined these troops that symmetrical yet bizarre heel contours were often noted among Negroes, while among the whites homogeneity of contour with a greater degree of asymmetry was more characteristic.

CORRELATIONS - The posterior heel contour correlates poorly, if at all, with length and breadth of the foot. There is a pronounced scatter of shapes such that a given length and/or breadth of the foot may be associated with a wide variety of heel contours (Table 50).

DUPLICATE MEASUREMENTS - Upon duplicate examination of the heel contours, it was found that the separate template selections were in agreement in 64.3% of the cases, differed by one gradation in 25.7%, and by more than one gradation in 10.0% of the cases.



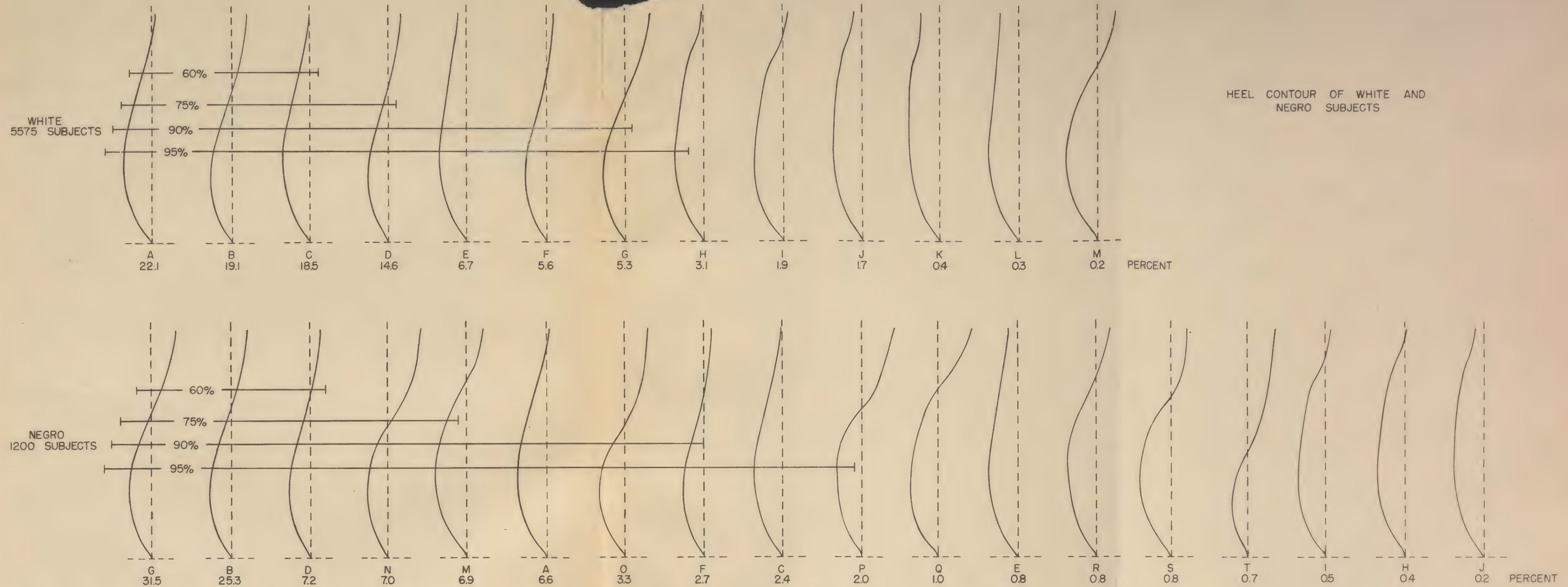


Figure 97



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COMPOSITE HEEL SHAPE LIMITS  
ACCOMMODATING THE INDICATED  
PERCENTAGE OF THE POPULATION

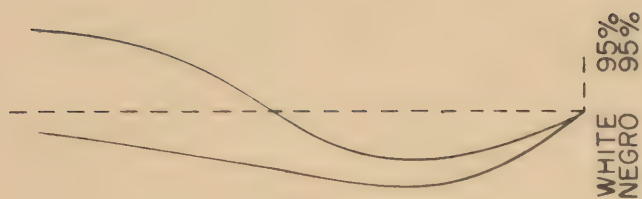


Figure 98

TABLE 50  
CORRELATION BETWEEN POSTERIOR HEEL CONTOUR AND LENGTH  
AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH mm. in.		POSTERIOR HEEL CONTOUR												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
84-89	3 5/16-3 8/16...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16..	.....	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	2
96-101	3 13/16-4 .....	.....	.....	.....	1	.....	1	1	.....	.....	.....	.....	.....	3
102-107	4 -4 3/16.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1
108-113	4 4/16-4 7/16...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		.....	.....	.....	1	2	2	1	.....	.....	.....	.....	.....	6

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16...	.....	.....	2	1	1	1	1	.....	.....	.....	.....	.....	6
90-95	3 9/16-3 12/16..	.....	3	7	3	3	7	2	.....	1	.....	.....	.....	26
96-101	3 13/16-4 .....	1	8	5	7	3	9	11	.....	.....	.....	.....	.....	44
102-107	4 -4 3/16.....	.....	.....	4	.....	.....	.....	5	.....	.....	.....	.....	.....	9
108-113	4 4/16-4 7/16...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		1	11	18	11	7	17	19	.....	1	.....	.....	.....	85

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16...	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
90-95	3 9/16-3 12/16..	.....	10	21	11	7	14	15	1	2	1	.....	2	84
96-101	3 13/16-4 .....	1	32	56	46	32	74	62	10	1	2	8	2	326
102-107	4 -4 3/16.....	1	14	30	20	15	18	22	1	1	3	3	.....	128
108-113	4 4/16-4 7/16...	.....	1	2	2	1	1	3	.....	.....	1	.....	.....	11
114-119	4 8/16-4 11/16..	.....	.....	1	1	.....	.....	1	.....	.....	.....	.....	.....	3
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		2	59	110	80	55	107	103	12	4	7	11	4	554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16...	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	1
90-95	3 9/16-3 12/16..	1	7	13	10	9	12	9	3	.....	1	1	.....	66
96-101	3 13/16-4 .....	2	51	133	120	46	106	127	30	1	17	19	10	662
102-107	4 -4 3/16.....	3	44	118	98	39	98	103	20	1	9	19	6	558
108-113	4 4/16-4 7/16...	1	10	13	21	5	12	15	1	.....	2	1	1	82
114-119	4 8/16-4 11/16..	.....	.....	1	3	.....	.....	.....	.....	.....	.....	.....	1	5
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		7	112	278	252	99	288	255	54	2	29	40	18	1374

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16..	.....	.....	.....	3	1	4	8	.....	.....	1	.....	.....	24
96-101	3 13/16-4 .....	.....	23	91	103	31	72	109	16	3	7	11	7	473
102-107	4 -4 3/16.....	4	68	195	208	53	144	197	46	5	22	38	19	999
108-113	4 4/16-4 7/16...	.....	14	53	64	14	40	53	19	.....	6	10	11	284
114-119	4 8/16-4 11/16..	.....	2	5	6	1	.....	4	1	1	1	1	.....	22
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
TOTAL.....		4	107	351	384	100	260	371	82	9	37	60	37	1802



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		POSTERIOR HEEL CONTOUR											TOTAL	
		1	2	3	4	5	6	7	8	9	10	11		12
mm.	in.													
84-89	3 5/16-3 8/16...													8
90-95	3 9/16-3 12/16..			2	3		1	1		1				178
96-101	3 13/16-4 .....		10	40	47	6	24	31	10	1	6	2	1	614
102-107	4 -4 3/16.....	2	34	93	170	19	83	116	46	3	11	22	15	341
108-113	4 4/16-4 7/16...	1	15	56	100	12	31	72	33	2	3	11	5	46
114-119	4 8/16-4 11/16..		3	7	8	1	9	9	4		1	2	2	4
120-125	4 12/16-4 15/16.			1		2					1			
TOTAL.....		3	63	198	330	38	147	229	94	6	23	37	23	1191

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16..	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1
96-101	3 13/16-4 .....	.....	1	2	6	1	3	4	3	.....	.....	.....	1	21
102-107	4 -4 3/16.....	.....	11	22	47	3	15	30	12	.....	5	8	3	156
108-113	4 4/16-4 7/16...	1	4	32	58	3	23	22	19	1	2	8	6	179
114-119	4 8/16-4 11/16..	.....	3	7	21	1	6	11	3	.....	.....	3	2	57
120-125	4 12/16-4 15/16.	.....	.....	1	1	.....	.....	2	1	.....	1	.....	.....	6
TOTAL.....		1	19	64	133	8	47	69	33	1	8	19	12	420

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
96-101	3 13/16-4 .....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	1
102-107	4 -4 3/16.....	.....	.....	5	4	.....	2	5	2	.....	1	.....	.....	19
108-113	4 4/16-4 7/16...	.....	3	3	17	1	2	5	4	.....	1	1	.....	37
114-119	4 8/16-4 11/16..	.....	.....	3	11	.....	1	5	1	.....	1	1	1	24
120-125	4 12/16-4 15/16.	.....	.....	.....	3	.....	.....	1	1	.....	.....	1	.....	6
TOTAL.....		.....	3	11	35	1	6	16	8	.....	3	3	1	87

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

34-39	3 5/16-3 8/16...	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
96-101	3 13/16-4 .....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
102-107	4 -4 3/16.....	.....	.....	1	1	.....	.....	1	.....	.....	.....	.....	.....	3
108-113	4 4/16-4 7/16...	.....	.....	.....	1	.....	.....	.....	1	.....	.....	.....	.....	2
114-119	4 8/16-4 11/16..	.....	.....	1	2	.....	.....	1	2	.....	1	.....	.....	7
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	1
TOTAL.....		.....	.....	2	4	.....	1	2	3	.....	1	.....	.....	13

## ANKLE GIRTH

**GENERAL** - This dimension was measured as illustrated in the accompanying photograph (Fig. 99). 98% of the white population is included within a range of  $3 \frac{13}{16}$  in. The Negro measurements tend to be larger than those of the white subjects (Fig. 100, Table 51).

**CORRELATIONS** - Diagonal ankle girth correlates moderately well with foot length and with foot breadth. There is a pronounced scatter of the measurements such that a given length and/or breadth of the foot may be associated with a wide variety of ankle girths (Table 52).

**DUPLICATE MEASUREMENTS** - The algebraic mean of the differences between duplicate measurements was found to be -0.7 mm., and the absolute mean difference without regard to sign was 5.0 mm. The difficulty encountered in accurately placing the tape on the foot led to the wide scatter of differences between duplicate measurements seen in Fig. 101.



Figure 99. Ankle Girth

TABLE 51  
DIAGONAL ANKLE GIRTH

No. Subjects	WHITE 5575		NEGRO 1200	
	mm.	in.	mm.	in.
Mean .....	344.1	$13 \frac{9}{16}$	349.9	$13 \frac{13}{16}$
100% range.....	292-398	$11 \frac{8}{16}$ - $16 \frac{11}{16}$	303-405	$11 \frac{15}{16}$ - $16 \frac{15}{16}$
98% range.....	309-381	$12 \frac{3}{16}$ - $16$	314-388	$12 \frac{6}{16}$ - $16 \frac{4}{16}$
95% range.....	314-374	$12 \frac{6}{16}$ - $14 \frac{12}{16}$	318-382	$12 \frac{8}{16}$ - $16 \frac{1}{16}$

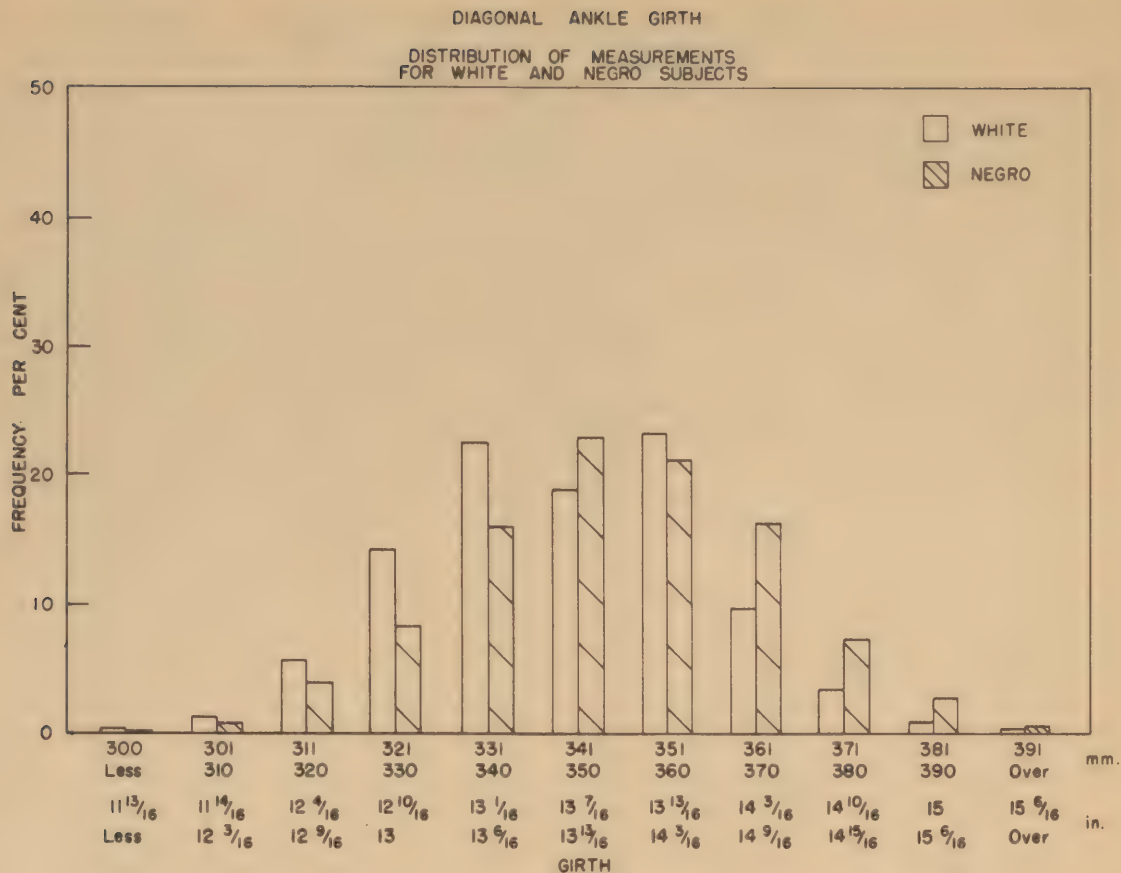


Figure 100

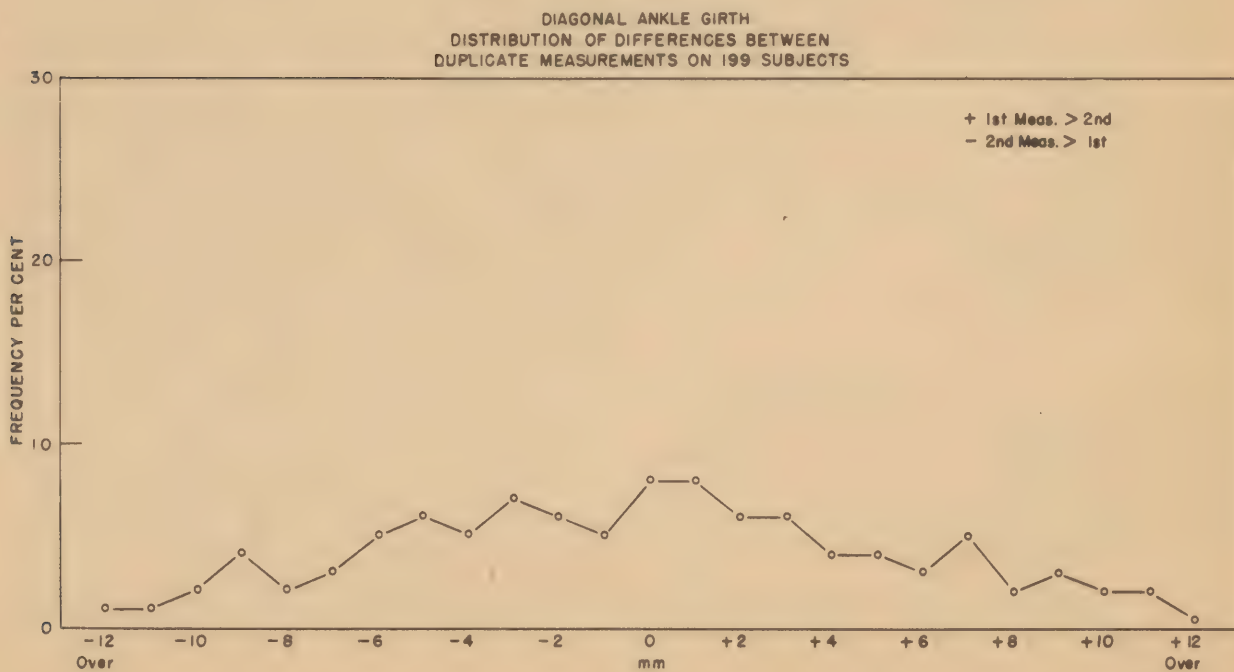


Figure 101



TABLE 52  
CORRELATION BETWEEN DIAGONAL ANKLE GIRTH AND LENGTH  
AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 8 3/16 in.)

DIAGONAL BREADTH		DIAGONAL ANKLE GIRTH											TOTAL	
		mm.	300- Less	301- 310	311- 320	321- 330	331- 340	341- 350	351- 360	361- 370	371- 380	381- 390		391- Over
		in.	11 13/16 & Less	11 14/16 12 3/16	12 4/16 12 9/16	12 10/16 13	13 1/16 13 6/16	13 7/16 13 13/16	14 3/16 14 9/16	14 10/16 14 15/16	16" 16 6/16	16 6/16 & Over		
mm.	in.													
84-89	3 5/16-3 8/16..													
90-95	3 9/16-3 12/16.		1	1									2	
96-101	3 13/16-4"		1		1	1							3	
102-107	4"-4 3/16.....					1							1	
108-113	4 4/16-4 7/16..													
114-119	4 8/16-4 11/16.													
120-125	4 12/16-4 15/16													
TOTAL.....			2	1	1	2							6	

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16..			1	3							2	6
90-95	3 9/16-3 12/16.			6	<u>10</u>	9	2						27
96-101	3 13/16-4"	3	12	<u>19</u>	11								<u>45</u>
102-107	4"-4 3/16.....		1	<u>2</u>	2	2	2						9
108-113	4 4/16-4 7/16..												
114-119	4 8/16-4 11/16.												
120-125	4 12/16-4 15/16												
TOTAL.....		3	20	<u>34</u>	22	4	2					2	87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16..	1				1							2
90-95	3 9/16-3 12/16.	2	13	28	<u>34</u>	6	1						84
96-101	3 13/16-4"		15	98	<u>122</u>	77	11	3					<u>326</u>
102-107	4"-4 3/16.....		1	17	<u>46</u>	<u>48</u>	13	3					<u>128</u>
108-113	4 4/16-4 7/16..			1	3	4	1	1	1				11
114-119	4 8/16-4 11/16.				2		1						3
120-125	4 12/16-4 15/16												
TOTAL.....		3	29	144	<u>208</u>	135	27	7	1				554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16..					1							1
90-95	3 9/16-3 12/16.		2	13	<u>26</u>	23	2						66
96-101	3 13/16-4"		10	76	220	<u>240</u>	98	20			1		<u>665</u>
102-107	4"-4 3/16.....			16	112	<u>226</u>	153	49	4				<u>560</u>
108-113	4 4/16-4 7/16..			2	4	27	<u>34</u>	13	3				83
114-119	4 8/16-4 11/16.						<u>2</u>	2		1			5
120-125	4 12/16-4 15/16												
TOTAL.....			12	107	362	<u>517</u>	289	84	7	1	1		1380

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16..												
90-95	3 9/16-3 12/16.			1	6	9	8						24
96-101	3 13/16-4"			16	78	<u>161</u>	160	48	11	1			475
102-107	4"-4 3/16.....			9	81	<u>261</u>	<u>380</u>	227	43	4			<u>1005</u>
108-113	4 4/16-4 7/16..				3	44	<u>103</u>	90	36	10			<u>286</u>
114-119	4 8/16-4 11/16.				1	2	<u>6</u>	2	8	3			22
120-125	4 12/16-4 15/16												
TOTAL.....				26	169	477	<u>657</u>	367	98	18			1812

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		DIAGONAL ANKLE GIRTH											TOTAL
		mm. 300- Less	301- 310	311- 320	321- 330	331- 340	341- 350	351- 360	361- 370	371- 380	381- 390	391- Over	
		in. 11 13/16 & Less	11 14/16 12 3/16	12 4/16 12 9/16	12 10/16 13"	13 1/16 13 6/16	13 7/16 13 13/16	13 13/16 14 3/16	14 3/16 14 9/16	14 10/16 15 1/16	16" 16 6/16	16 6/16 & Over	
mm.	in.												
84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8
90-95	3 9/16-3 12/16..	.....	.....	.....	2	4	1	1	.....	.....	.....	.....	178
96-101	3 13/16-4".....	.....	.....	1	10	36	71	40	18	2	.....	.....	619
102-107	4"-4 3/16.....	.....	.....	2	7	58	189	225	120	17	1	.....	347
108-113	4 4/16-4 7/16..	.....	.....	.....	2	18	56	130	103	34	3	1	46
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	.....	2	14	21	7	2	.....	4
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	2	2	.....	.....	.....	.....
TOTAL.....		.....	.....	3	21	116	319	412	264	60	6	1	1202

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16..	.....	.....	.....	.....	.....	1	.....	.....	1	.....	.....	2
96-101	3 13/16-4".....	.....	.....	.....	.....	2	5	9	4	1	.....	.....	21
102-107	4"-4 3/16.....	.....	.....	.....	.....	7	29	50	50	16	4	1	157
108-113	4 4/16-4 7/16..	.....	.....	.....	.....	1	12	47	71	37	11	1	180
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	.....	1	11	17	18	8	3	58
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	2	2	1	1	6
TOTAL.....		.....	.....	.....	.....	10	48	117	144	75	24	6	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
96-101	3 13/16-4".....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1
102-107	4"-4 3/16.....	.....	.....	.....	.....	.....	.....	2	6	7	4	.....	19
108-113	4 4/16-4 7/16..	.....	.....	.....	.....	.....	2	3	12	14	6	1	38
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	.....	.....	3	5	7	5	4	24
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	1	1	3	1	6
TOTAL.....		.....	.....	.....	.....	.....	2	8	24	30	18	6	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
90-95	3 9/16-3 12/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
96-101	3 13/16-4".....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
102-107	4"-4 3/16.....	.....	.....	.....	.....	.....	.....	.....	1	2	.....	.....	3
108-113	4 4/16-4 7/16..	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	2
114-119	4 8/16-4 11/16..	.....	.....	.....	.....	.....	.....	.....	.....	1	3	3	7
120-125	4 12/16-4 15/16.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
TOTAL.....		.....	.....	.....	.....	.....	.....	.....	1	3	5	4	13

## ANKLE LENGTH

GENERAL - This dimension was measured as illustrated in the accompanying photograph (Fig. 102). The reference mark on the posterior aspect of the leg, 65 mm. above the ground was chosen arbitrarily. 98% of the white subjects is included within a range of  $1 \frac{8}{16}$  in. The Negro measurements tend to be larger than those for the white subjects. (Fig. 103, Table 53).

CORRELATIONS - Ankle length correlates only moderately well with foot length, and poorly, if at all, with foot breadth. There is a pronounced scatter of the measurements such that a given foot length and/or breadth may be associated with a wide variety of ankle lengths (Table 54).

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be -0.1 mm., and the absolute mean difference without regard to sign was 1.5 mm. The range of differences is shown in Fig. 104.



Figure 102  
Ankle Length

TABLE 53

### ANKLE LENGTH

No. Subjects	WHITE 5574		NEGRO 1200	
	mm.	in.	mm.	in.
Mean .....	111.3	$4 \frac{6}{16}$	113.7	$4 \frac{8}{16}$
100% range.....	87-139	$3 \frac{7}{16} - 5 \frac{8}{16}$	95-139	$3 \frac{12}{16} - 5 \frac{8}{16}$
98% range.....	97-127	$3 \frac{13}{16} - 5$	99-131	$3 \frac{14}{16} - 5 \frac{3}{16}$
95% range.....	99-124	$3 \frac{14}{16} - 4 \frac{14}{16}$	101-128	$4 - 5 \frac{1}{16}$



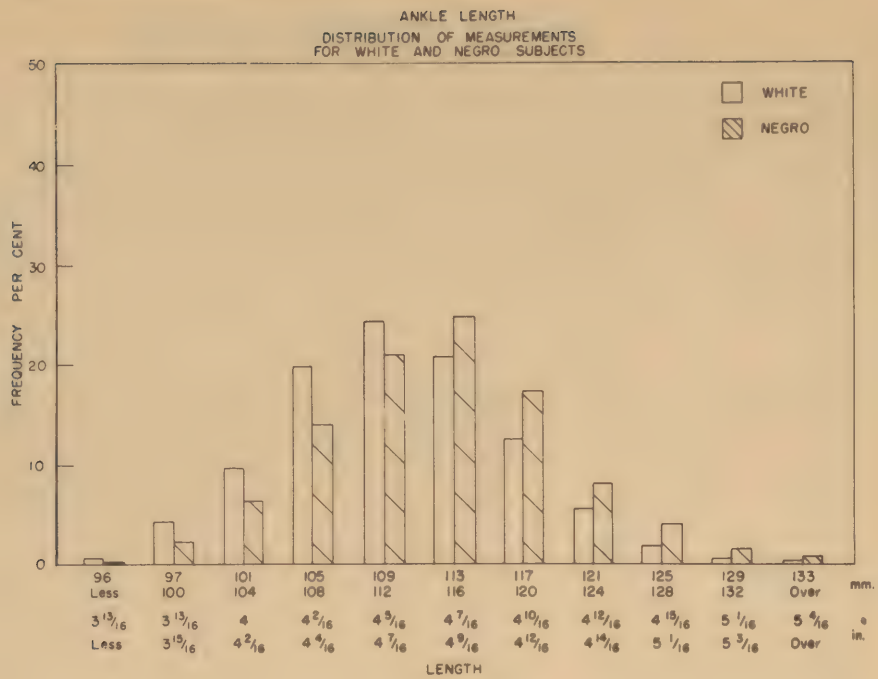


Figure 103

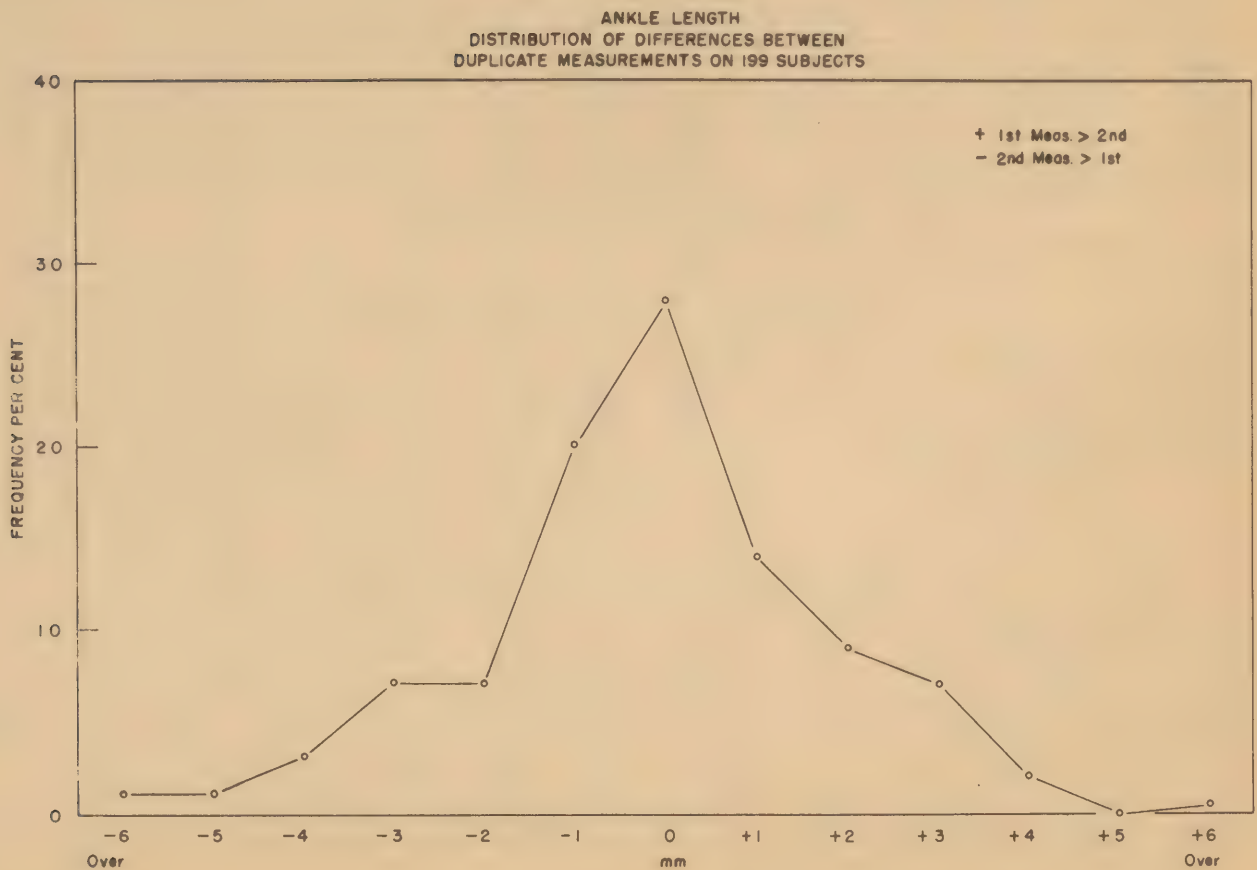


Figure 104

TABLE 54  
CORRELATION BETWEEN ANKLE LENGTH AND LENGTH  
AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		ANKLE LENGTH											T O T A L
		mm. 96- Less	97-100	101-104	105-109	109-112	113-116	117-120	121-124	125-128	129-132	133 & Over	
		in. 3 13/16 & Less	3 13/16- 3 15/16	4"- 4 2/16	4 3/16- 4 4/16	4 5/16- 4 7/16	4 7/16- 4 9/16	4 10/16- 4 12/16	4 12/16- 4 14/16	4 15/16 5 1/16	5 1/16- 5 3/16	4/16 & Over	
mm.	in.												
84-89	3 5/16-3 8/16...												
90-95	3 9/16-3 12/16..	2										2	
96-101	3 13/16-4 .....	1		2								3	
102-107	4 -4 3/16.....					1						1	
108-113	4 4/16-4 7/16...												
114-119	4 8/16-4 11/16..												
120-125	4 12/16-4 15/16.												
TOTAL.....		3		2		1						6	

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16-3 8/16...	2	4										6
90-95	3 9/16-3 12/16..	4	10	6	5	2							27
96-101	3 13/16-4 .....	11	20	13	1								45
102-107	4 -4 3/16.....		4	3	2								9
108-113	4 4/16-4 7/16...												
114-119	4 8/16-4 11/16..												
120-125	4 12/16-4 15/16.												
TOTAL.....		17	38	22	8	2							87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16-3 8/16...			2									2
90-95	3 9/16-3 12/16..	5	30	32	14	1							84
96-101	3 13/16-4 .....	7	77	116	94	26	6						326
102-107	4 -4 3/16.....	2	14	29	58	18	5	2					128
108-113	4 4/16-4 7/16...			1	3	4		2					11
114-119	4 8/16-4 11/16..		1	2		1							3
120-125	4 12/16-4 15/16.												
TOTAL.....		14	122	182	169	50	13	4					554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16-3 8/16...				1								1
90-95	3 9/16-3 12/16..		9	23	20	13	1						66
96-101	3 13/16-4 .....	4	43	137	270	170	31	10					665
102-107	4 -4 3/16.....		11	83	197	187	69	11	2				560
108-113	4 4/16-4 7/16...		3	6	17	32	21	4					83
114-119	4 8/16-4 11/16..					1	3			1			5
120-125	4 12/16-4 15/16.												
TOTAL.....		4	66	249	505	403	125	25	2	1			1380

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16-3 8/16...												
90-95	3 9/16-3 12/16..			3	6	9	5	1					24
96-101	3 13/16-4 .....	1	4	30	120	181	114	24	1				475
102-107	4 -4 3/16.....		3	42	198	359	298	88	15	1	1		1005
108-113	4 4/16-4 7/16...			4	36	91	91	52	11	1			286
114-119	4 8/16-4 11/16..				2	3	7	6	2	2			22
120-125	4 12/16-4 15/16.												
TOTAL.....		1	7	79	362	643	515	171	29	4	1		1812

LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		ANKLE LENGTH										T O T A L	
		mm. 96- Less	97-100	101-104	105-108	109-112	113-116	117-120	121-124	125-128	129-132		133 & Over
		in. 3 13/16 & Less	3 13/16- 3 15/16	4"- 4 2/16	4 3/16- 4 4/16	4 5/16- 4 7/16	4 7/16- 4 9/16	4 10/16- 4 12/16	4 12/16- 4 14/16	4 15/16- 5 1/16	5 1/16- 5 3/16		4/16 & Over
mm.	in.												
84-89	3 5/16-3 8/16...												8
90-95	3 9/16-3 12/16...		1	6	1				6	1			178
96-101	3 13/16-4 .....			3	15	51	75	27					619
102-107	4 -4 3/16.....			4	35	124	229	163	51	10	2	1	347
108-113	4 4/16-4 7/16...			2	5	49	111	125	46	9			46
114-119	4 8/16-4 11/16...			6	10	25	5						4
120-125	4 12/16-4 15/16.							1	3				
TOTAL.....			1	21	66	249	420	316	106	20	2	1	1202

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16-3 8/16...												2
90-95	3 9/16-3 12/16...						1		1				21
96-101	3 13/16-4 .....				2	3	5	9		1	1		157
102-107	4 -4 3/16.....				1	10	37	53	40	14	2		180
108-113	4 4/16-4 7/16...					6	26	56	60	26	5	1	58
114-119	4 8/16-4 11/16...						4	23	18	8	5		6
120-125	4 12/16-4 15/16.							1	4		1		
TOTAL.....					3	19	73	142	123	49	14	1	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16-3 8/16...												1
90-95	3 9/16-3 12/16...												19
96-101	3 13/16-4 .....									1			38
102-107	4 -4 3/16.....				2	7	8	2					24
108-113	4 4/16-4 7/16...						2	8	11	12	5		6
114-119	4 8/16-4 11/16...							5	8	4	5	2	
120-125	4 12/16-4 15/16.							1	1	1	3		
TOTAL.....					2	7	10	16	20	18	13	2	88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16-3 8/16...												
90-95	3 9/16-3 12/16...												
96-101	3 13/16-4 .....												3
102-107	4 -4 3/16.....									2	1		2
108-113	4 4/16-4 7/16...									2			7
114-119	4 8/16-4 11/16...								1	2	1	3	1
120-125	4 12/16-4 15/16.										1		
TOTAL.....									1	6	3	3	13



## LOWER LEG GIRTH

GENERAL - This dimension was measured as illustrated in the accompanying photograph (Fig. 105). The reference mark 125 mm. above the ground was chosen to represent the approximate top of present service shoes. 98% of the white population is included within a range of 2 6/16 in. The Negro measurements tend to be smaller than those of the white subjects (Fig. 106, Table 55).

CORRELATIONS - Lower leg girth correlates poorly, if at all, with foot length and with foot breadth. There is a pronounced scatter of the measurements such that a given foot length and/or breadth may be associated with a wide variety of leg girths (Table 56).

DUPLICATE MEASUREMENTS - The algebraic mean of the differences between duplicate measurements was found to be -0.6 mm., and the absolute mean difference without regard to sign was 2.2 mm. The range of differences is shown in Fig. 107.



Figure 105

Lower Leg Girth

TABLE 55

LOWER LEG GIRTH

No. Subjects	WHITE 5575		NEGRO 1200	
	mm.	in.	mm.	in.
Mean.....	220.7	8 11/16	217.9	8 9/16
100% range.....	183-278	7 3/16 - 10 15/16	183-278	7 3/16 - 10 15/16
98% range.....	194-254	7 10/16 - 10	193-249	7 10/16 - 9 13/16
95% range.....	198-247	7 13/16 - 9 12/16	196-244	7 12/16 - 9 10/16

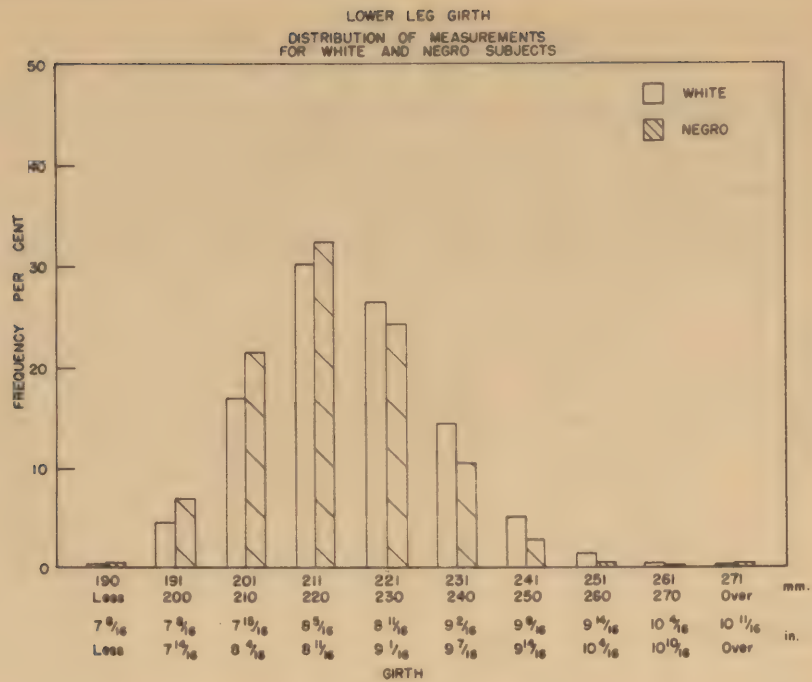


Figure 106

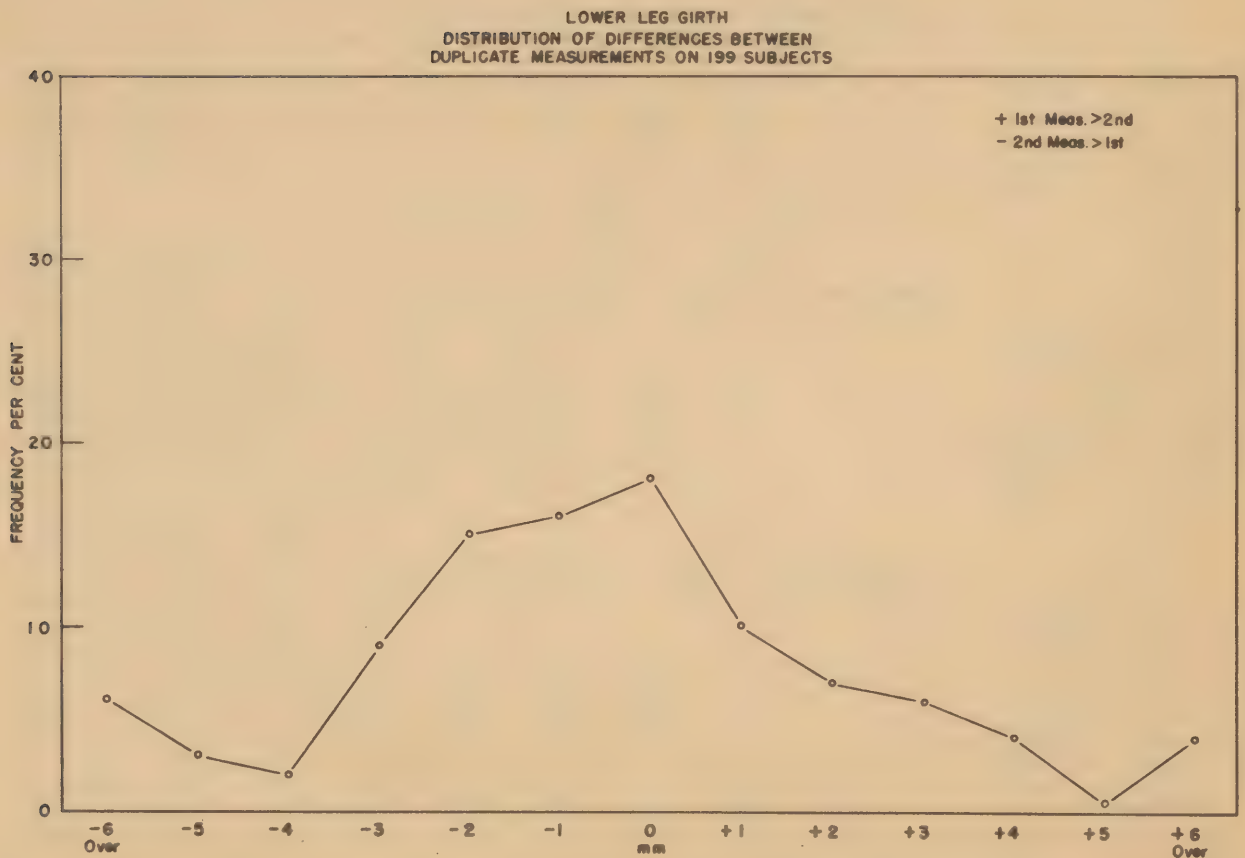


Figure 107

TABLE 56  
CORRELATION BETWEEN LOWER LEG GIRTH  
AND LENGTH AND BREADTH OF THE FOOT FOR WHITE SUBJECTS

LENGTH GROUP 225 to 234 mm. (8 14/16 to 9 3/16 in.)

DIAGONAL BREADTH		LOWER LEG GIRTH										TOTAL	
		mm.	190- Less	191-200	201-210	211-220	221-230	231-240	241-250	251-260	261-270		271- Over
		in.	7 8/16 & Less	7 8/16- 7 14/16	7 15/16 8 4/16	8 5/16 8 11/16	8 11/16 9 1/16	9 2/16 9 7/16	9 8/16 9 14/16	9 14/16 10 4/16	10 4/16 10 10/16		10 11/16 & Over
mm.	in.												
84-89	3 5/16 - 3 8/16..												
90-95	3 9/16 - 3 12/16.			2								2	
96-101	3 13/16 - 4.....			1	1	1						3	
102-107	4 - 4 3/16.....				1							1	
108-113	4 4/16 - 4 7/16..												
114-119	4 8/16 - 4 11/16.												
120-125	4 12/16 - 4 15/16												
TOTAL.....				3	2	1						6	

LENGTH GROUP 235 to 244 mm. (9 4/16 to 9 10/16 in.)

84-89	3 5/16 - 3 8/16..	3	2	1									6
90-95	3 9/16 - 3 12/16..		5	<u>12</u>	8	2							27
96-101	3 13/16 - 4.....	5	13	<u>18</u>	9								<u>45</u>
102-107	4 - 4 3/16.....		3	<u>2</u>	2		1	1					9
108-113	4 4/16 - 4 7/16..												
114-119	4 8/16 - 4 11/16..												
120-125	4 12/16 - 4 15/16												
TOTAL.....		8	23	<u>33</u>	19	2	1	1					87

LENGTH GROUP 245 to 254 mm. (9 10/16 to 10 in.)

84-89	3 5/16 - 3 8/16..		1		1								2
90-95	3 9/16 - 3 12/16..	7	24	42	7	2	2						84
96-101	3 13/16 - 4.....	2	59	<u>129</u>	<u>103</u>	32	1						<u>326</u>
102-107	4 - 4 3/16.....		4	27	<u>62</u>	25	7	3					<u>128</u>
108-113	4 4/16 - 4 7/16..		1		<u>5</u>	2	3						11
114-119	4 8/16 - 4 11/16..				<u>2</u>				1				3
120-125	4 12/16 - 4 15/16												
TOTAL.....		9	89	<u>198</u>	180	61	13	3	1				554

LENGTH GROUP 255 to 264 mm. (10 1/16 to 10 6/16 in.)

84-89	3 5/16 - 3 8/16..				1								1
90-95	3 9/16 - 3 12/16..	1	16	<u>35</u>	13	1							66
96-101	3 13/16 - 4.....	3	67	<u>213</u>	<u>274</u>	87	20	1					<u>665</u>
102-107	4 - 4 3/16.....		19	107	<u>217</u>	159	49	8	1				<u>560</u>
108-113	4 4/16 - 4 7/16..		1	4	<u>29</u>	26	16	6	1				83
114-119	4 8/16 - 4 11/16..					3	1	1					5
120-125	4 12/16 - 4 15/16												
TOTAL.....		4	103	359	<u>534</u>	273	88	16	3				1380

LENGTH GROUP 265 to 274 mm. (10 7/16 to 10 13/16 in.)

84-89	3 5/16 - 3 8/16..												
90-95	3 9/16 - 3 12/16..	1	3	8	7	4	1						24
96-101	3 13/16 - 4.....		17	129	199	102	27	1					475
102-107	4 - 4 3/16.....	1	10	119	<u>350</u>	<u>350</u>	144	28	3				<u>1005</u>
108-113	4 4/16 - 4 7/16..		1	16	66	<u>105</u>	68	25	3	1	1		<u>286</u>
114-119	4 8/16 - 4 11/16..				3	<u>4</u>	8	5	2				22
120-125	4 12/16 - 4 15/16												
TOTAL.....		2	31	272	<u>625</u>	565	248	59	8	1	1		1812



LENGTH GROUP 275 to 284 mm. (10 13/16 to 11 3/16 in.)

DIAGONAL BREADTH		LOWER LEG GIRTH									TOTAL		
		mm.	190- Less	191-200	201-210	211-220	221-230	231-240	241-250	251-260		261-270	271- Over
		in.	7 8/16 & Less	7 8/16- 7 14/16	7 15/16- 8 4/16	8 5/16- 8 11/16	8 11/16- 9 1/16	9 2/16- 9 7/16	9 8/16- 9 14/16	9 14/16- 10 4/16		10 4/16- 10 10/16	10 11/16 & Over
mm.	in.												
84-89	3 5/16 - 3 8/16..												
90-95	3 9/16 - 3 12/16..		1	5	2							8	
96-101	3 13/16 - 4.....		5	17	67	65	19	4	1			178	
102-107	4 - 4 3/16.....		4	42	146	262	122	34	9			619	
108-113	4 4/16 - 4 7/16..			8	49	125	101	47	13	4		347	
114-119	4 8/16 - 4 11/16..				2	9	18	12	4	1		46	
120-125	4 12/16 - 4 15/16						4					4	
TOTAL.....			10	72	266	461	264	97	27	5		1202	

LENGTH GROUP 285 to 294 mm. (11 4/16 to 11 9/16 in.)

84-89	3 5/16 - 3 8/16..											2
90-95	3 9/16 - 3 12/16..				1		1					21
96-101	3 13/16 - 4.....				8	9	3	1				157
102-107	4 - 4 3/16.....		1	2	28	50	59	13	3	1		180
108-113	4 4/16 - 4 7/16..			2	12	41	70	40	12	2	1	58
114-119	4 8/16 - 4 11/16..				2	9	19	11	10	6	1	6
120-125	4 12/16 - 4 15/16						2	3	1			
TOTAL.....			1	4	51	109	154	68	26	9	2	424

LENGTH GROUP 295 to 304 mm. (11 10/16 to 12 in.)

84-89	3 5/16 - 3 8/16..											1
90-95	3 9/16 - 3 12/16..											19
96-101	3 13/16 - 4.....		1									38
102-107	4 - 4 3/16.....				1	4	12	2				24
108-113	4 4/16 - 4 7/16..					2	16	16	4			6
114-119	4 8/16 - 4 11/16..				1	2	6	10	1	4		
120-125	4 12/16 - 4 15/16						1		3	2		
TOTAL.....			1		2	8	35	28	8	6		88

LENGTH GROUP 305 to 314 mm. (12 to 12 6/16 in.)

84-89	3 5/16 - 3 8/16..											3
90-95	3 9/16 - 3 12/16..											2
96-101	3 13/16 - 4.....											7
102-107	4 - 4 3/16.....					1	1	1				1
108-113	4 4/16 - 4 7/16..						1	1				
114-119	4 8/16 - 4 11/16..						3	2	1	1		
120-125	4 12/16 - 4 15/16								1			
TOTAL.....						1	5	4	2	1		13



## CLINICAL EVALUATION

## A. INTRODUCTORY

Clinical examinations were made of all subjects' feet by competent medical officers. By means of preliminary examinations made in concert it was possible for them to arrive at identical or nearly identical judgments regarding each individual case. The clinical opinions expressed are, therefore, reasonably uniform throughout the study.

The objectives of the clinical examinations were to attempt to visually identify foot types and to describe those structural and shape characteristics which might determine the presence of non-average dimensions. The general premise was that certain basic symmetry may be common to all feet, varied in individual cases or groups of cases by irregularities in one region or another. Such symmetry implies proportional relationships of the various foot dimensions. If foot types were to be found each type should be characterized by more or less uniform dimensional proportions. Foot types might also be identified on the basis of the presence or absence of such conditions as varus or valgus, high or low arch, abundant or scant subcutaneous tissue and so on. The usefulness of foot typing in either case would depend on the rapid recognizability of each type by inspection.

## B. PLAN OF CLINICAL DESCRIPTION

The following foot characteristics were selected for their probable importance, and each subject was examined to detect their presence or absence.

## Scheme for Clinical Evaluation

- 1 - Fleshy Foot - More than average subcutaneous tissue. Smoothing of tendons, veins, and bony markings.
- 2 - Lean Foot - Less than average subcutaneous tissue. Tendons, etc., prominent.
- 3 - High Arch - Substantially greater than average height of dorsal and/or planter curvature of the arch.
- 4 - Low Arch - Substantially smaller than average height of dorsal and/or planter curvature of the arch.
- 5 - Inflare - Marked medial deviation of the region of the metatarsal heads; varus and/or supination are included.
- 6 - Outflare - Marked lateral deviation of the region of the metatarsal heads independent of rotation of the leg; valgus and/or pronation are included.
- 7 - Long Toes - Longer than average expected for a particular length of foot.
- 8 - Short Toes - Shorter than average expected for a particular length of foot.
- 9 - Elevation of Toes - Distinct dorsal prominence of the interphalangeal joints due to digital contracture, or elevation of the entire digit probably due to physical displacement. (Fig. 108)
- 10 - Bunion - Marked medial prominence of the 1st metatarso-phalangeal joint. (Fig. 109)





Figure 108  
Clinically Elevated - 5th Toe



Figure 109  
Clinical Bunion



Figure 110  
Clinically Prominent Heel

- 11- Prominent Scaphoid Tuberosity - Recorded only when prominent, and distinguished from the sustentaculum tali.
- 12- Asymmetry of the Posterior Heel surface - Only the larger localized protuberances were regarded as significant. (Fig. 110).

Inasmuch as the subjects with gross deformities (Atrophy, edema, etc.) were excluded from the study (App. 3), all those who did not fit into the above classifications were by exclusion classified as non-exceptional, normal, or average. These are terms of convenience; the possession of some of the attributes listed above obviously does not imply abnormality.

# C. RESULTS

Table 57 shows the incidence of the attributes described:

TABLE 57

## SUMMARY OF CLINICAL FINDINGS\*

WHITE SUBJECTS		NEGRO SUBJECTS	
EVALUATION	FREQUENCY PERCENT	EVALUATION	FREQUENCY PERCENT
Average, Normal or Non-exceptional . . . . .	69.44	Average, Normal or Non-exceptional . . . . .	52.76
Low Arch . . . . .	8.64	Low Arch . . . . .	18.75
Posterior Heel Asymmetry .	7.42	Fleshy Foot . . . . .	9.98
High Arch . . . . .	4.72	Elevation of Toes . . . .	4.46
Fleshy Foot . . . . .	2.35	Bunion . . . . .	3.55
Short Toes . . . . .	2.49	High Arch . . . . .	2.65
Long Toes . . . . .	1.74	Outflare . . . . .	2.34
Elevation of Toes . . . . .	1.70	Posterior Heel Asymmetry.	1.81
Lean Foot . . . . .	0.56	Short Toes . . . . .	1.44
Inflare . . . . .	0.22	Long Toes . . . . .	1.06
Bunion . . . . .	0.34	Lean Foot . . . . .	0.91
Outflare . . . . .	0.25	Inflare . . . . .	0.30
Prom. Scaphoid Tuberosity .	0.13	Prom. Scaphoid Tuberosity	0.00
	99.96		99.92

\* Approximately 5% of the subjects were found to possess 2 of the above foot attributes simultaneously. It was extremely rare to encounter a subject with 3 of these attributes and none had more than 3.

Low arch was the most frequent deviation from "Normal" among both whites (8.6%) and Negroes (18.8%), although among Negroes its incidence was more than twice that noted among whites. The clinical judgment of low arch was made on the basis of the apparent height of both the dorsal foot surface and the planter arch curvature, and measurements were made of both these dimensions. Figs. 111 & 112 show the distribution of the planter and dorsal arch heights

PLANTAR ARCH HEIGHT  
DISTRIBUTION OF MEASUREMENTS  
OF WHITE SUBJECTS WITH  
HIGH, LOW, & NORMAL ARCHES

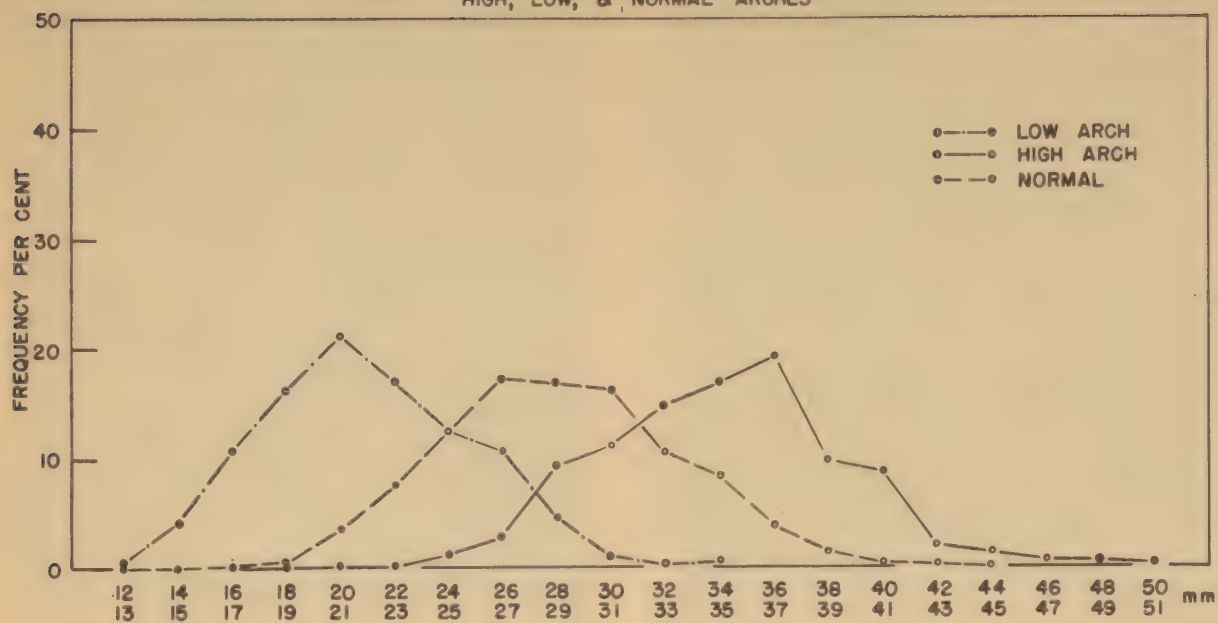


Figure 111

DORSAL ARCH HEIGHT  
DISTRIBUTION OF MEASUREMENTS  
OF WHITE SUBJECTS WITH  
HIGH, LOW, & NORMAL ARCHES

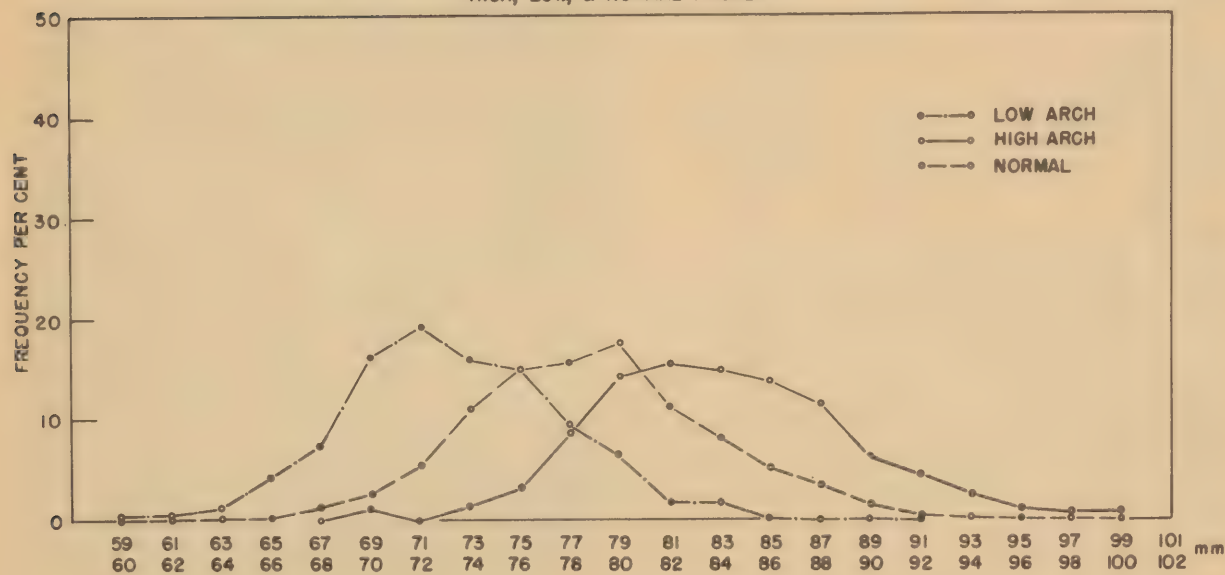


Figure 112



for the subjects clinically judged to have high arches, low arches and arches of average height. It is apparent that judgment on the basis of inspection is subject to error, since in many instances the measurements fail to substantiate the visual impression, as evidenced by the overlapping of the curves. The length and breadth of the foot apparently bear little if any relationship to the actual height of the arch, although they may influence the clinical judgment.

Localized protrusions on the posterior heel surface were the next most frequently identified attribute among the white subjects. These were observed for the most part lateral to the mid-line and just superior to the os calcis, or at its upper margin, and were thought to be of connective tissue rather than bony structure. They were observed on 7.4% of the white subjects, although among the Negroes they were noted on only 1.8% of the subjects. As pointed out elsewhere, there were many Negro heels of bizarre shape as compared with the whites whose heel shapes were characterized by greater homogeneity. On the other hand, lack of symmetry due to localized prominences was much more frequently noted among the white subjects.

The presence of abundant subcutaneous tissue (fleshy foot) was frequent among the Negroes (10.0%), whereas it was much more rare among the whites (2.4%). This greater tendency toward fleshiness of the foot among the Negroes is doubtless related to the tendency of the Negroes to have large average foot girths and breadths than the whites. It would seem possible that the bony dimensions of whites and Negroes may not be greatly dissimilar, but that the thickness of soft tissue overlying the bone is responsible for the difference in measurements encountered.

Elevation of the dorsal digital surfaces whether of the toe as an entirety as is sometimes encountered for the 4th and 5th digits, or of the interphalangeal joints due to tendon contracture, was observed less frequently among the white subjects (1.7%) than among the Negroes (4.5%). Elsewhere it is pointed out (App. 4, Fig. 50) that the most frequently dorsally prominent toe is the 1st among the white subjects, while the 2nd toe was found to be the most frequently prominent among the Negroes. One is tempted to speculate on the influence of shoes with pointed toes in this regard. In both groups, the 5th toes were found to be prominent in about 10% of the subjects. The height of the toe from the ground is influenced by the presence or absence of an elevation deformity as shown in Fig. 113.

Outflare, valgus and eversion were described only rarely by the medical officers. This is at variance with the findings elsewhere noted: i.e., that the forepart of the foot tends to be laterally deviated relative to the heel axis (App 4, Figs. 64 & 65, Table 28). The reasons for this are probably that the clinical designation of outflare was applied only to the extreme cases, and outflare may not be as apparent upon examination of the dorsal aspect of the foot as it is when the plantar surface is examined. Pronation was not described since when marked it is associated with the lateral deviation of the foot described as outflare, and since little agreement exists concerning the criteria for distinguishing the milder degrees of pronation.

# TOE HEIGHT

## DISTRIBUTION OF MEASUREMENTS OF WHITE SUBJECTS WITH AND WITHOUT ELEVATION OF THE DIGITS

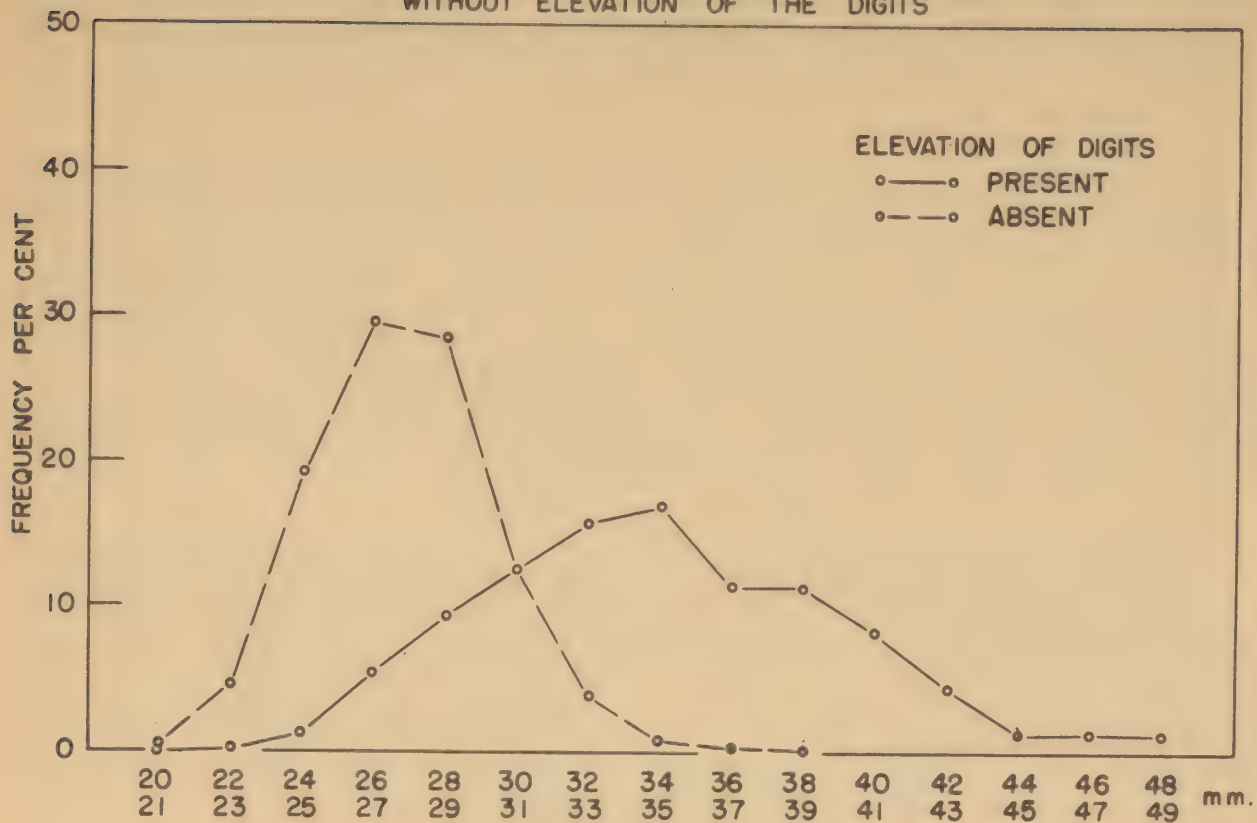


Figure 113

### D. CONCLUSIONS

From these observations it must be concluded that foot typing by clinical examination rests on insecure ground. The only attributes that occur with reasonable frequency and which may conceivably influence the proportional interrelationships of foot dimensions, are fleshy foot and low arch. As Figs. 111, 112 & 113 reveal, however, the measurements are not consistently in accord with the judgments of the medical officers. This is an insurmountable obstacle if typing is to be put to practical use.

## MISCELLANEOUS STUDIES

## A. CORRELATION STUDIES OF A SELECTED SEGMENT OF THE POPULATION

Because of the possibility that the relatively large measurement groupings utilized in the preceding survey of the data may have obscured whatever consistency exists in the interrelationships of the various foot dimensions, a distribution of the dimensional characteristics of a selected segment of the population possessing nearly identical length and width measurements has been prepared.

It was found that there were 831 white subjects (14.8%) whose foot lengths ranged from 265 to 268 mm. (10 7/16 - 10 9/16 in.) inc. This range is roughly equivalent to about one half size and closely approximates size 8½. The distribution of widths among this group was as follows:

Table 58

## Frequency Distribution by Width

For Length Group 265 - 268 mm.

mm.	No. Subj.	mm.	No. Subj.
84-85	3	98-99	150
86-87	8	100-101	142
88-89	17	102-103	83
90-91	40	104-105	37
92-93	65	106-107	19
94-95	95	108-109	9
96-97	161	110-111	2

From among these, the three most frequently represented widths were selected: width groups 96-97 mm., 98-99., and 100-101 mm. This analysis is therefore of those subjects most closely representative of the central tendency of the population, 453 subjects in all.

For each width group, distributions for the following eight selected other foot dimensions were then prepared:

Ball Length	Outside Ball Height
Ball Width (Diagonal)	Dorsal Arch Height
Ball Girth	Instep Breadth
Ball Height	Heel Width

Inspection of the appended tables and charts reveals that just as there is a wide spread of widths for this limited length group (Table 58), so for each of the widths there is an equally wide spread of other foot dimensions (Figs. 114 to 121, Tables 59 to 66). In whatever manner each set of measurements may be grouped, a large number of individuals still remain whose various foot dimensions fail to approximate the central tendency. This is true even for those dimensions which might be assumed to be closely related to length, such as ball length, and for those assumed to be closely related to width, such as ball girth. The scatter is less striking for those dimensions naturally characterized by a narrow range, such as ball height.



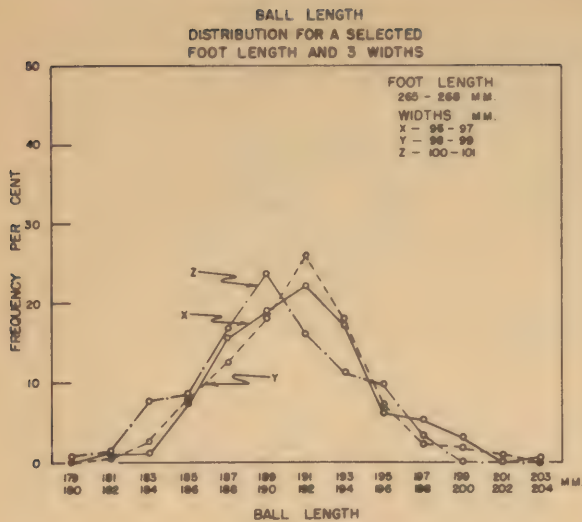


Figure 114

TABLE 59  
Distribution Of BALL LENGTH For  
LENGTH GROUP 265-268 mm (10 7/16-10 9/16 in)inc.  
And Subdivided For The  
Three Most Frequent Width Groups

mm	in	Frequency Percent		
		WIDTH (mm and inches)		
		X	Y	Z
		96-97 3 13/16- 3 13/16	98-99 3 14/16- 3 14/16	100-101 3 15/16- 4
178	7	.00	.67	.00
179	7 1/16	.00	.00	.00
180	7 1/16	.00	.00	.70
181	7 2/16	.62	.00	.00
182	7 3/16	.62	.67	1.41
183	7 3/16	.00	.00	2.82
184	7 4/16	1.24	2.67	4.93
185	7 5/16	1.24	1.33	.70
186	7 5/16	6.21	6.67	7.75
187	7 6/16	4.97	4.00	4.23
188	7 6/16	10.56	8.67	12.68
189	7 7/16	6.83	4.00	4.93
190	7 8/16	12.42	14.00	19.01
191	7 8/16	8.70	10.00	2.82
192	7 9/16	13.66	16.00	13.38
193	7 10/16	4.97	5.33	6.34
194	7 10/16	12.42	12.67	4.93
195	7 11/16	1.86	2.67	2.82
196	7 12/16	4.35	4.67	7.04
197	7 12/16	1.86	1.33	2.11
198	7 13/16	3.73	1.33	1.41
199	7 13/16	1.24	1.33	.00
200	7 14/16	1.86	.67	.00
201	7 15/16	.00	1.33	.00
202	7 15/16	.00	.00	.00
203	8	.62	.00	.00
Total (%)		99.98	100.01	100.01
No. Subj:		161	150	142

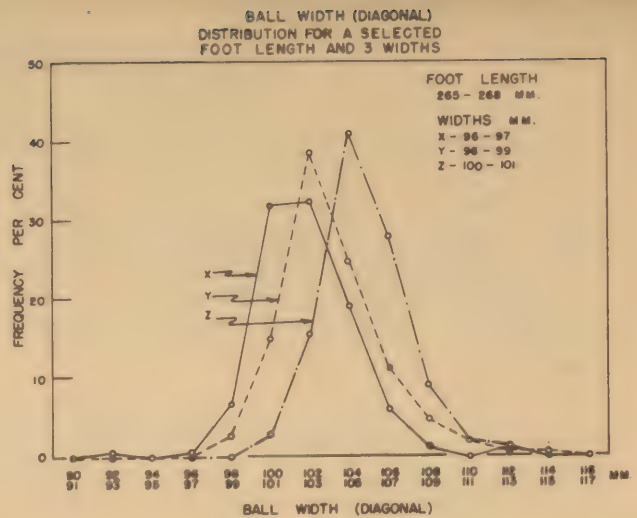


Figure 115

TABLE 60  
Distribution Of BALL WIDTH (DIAGONAL) For  
LENGTH GROUP 265-268 mm (10 7/16-10 9/16 in)inc.  
And Subdivided For The  
Three Most Frequent Width Groups

mm	in	Frequency Percent		
		WIDTH (mm and inches)		
		X	Y	Z
		96-97 3 13/16- 3 13/16	98-99 3 14/16- 3 14/16	100-101 3 15/16- 4
90	3 9/16	.00	.00	.00
91	3 9/16	.00	.00	.00
92	3 10/16	.62	.00	.00
93	3 11/16	.00	.00	.00
94	3 11/16	.00	.00	.00
95	3 12/16	.00	.00	.00
96	3 13/16	.62	.00	.00
97	3 13/16	.00	.00	.00
98	3 14/16	5.59	2.67	.00
99	3 14/16	1.24	.00	.00
100	3 15/16	23.60	10.67	2.11
101	4	8.07	4.00	.70
102	4	26.08	30.67	11.27
103	4 1/16	6.21	8.00	4.23
104	4 2/16	16.77	19.33	32.39
105	4 2/16	2.48	5.33	8.45
106	4 3/16	6.21	11.33	26.06
107	4 3/16	.00	.00	2.11
108	4 4/16	1.24	4.67	8.45
109	4 5/16	.00	.00	.70
110	4 5/16	.00	2.00	2.11
111	4 6/16	.00	.00	.00
112	4 7/16	1.24	.67	1.41
113	4 7/16	.00	.00	.00
114	4 8/16	.00	.00	.00
115	4 8/16	.00	.67	.00
116	4 9/16	.00	.00	.00
Total (%)		99.97	100.01	99.99
No Subj:		161	150	142

**TABLE 61**  
**Distribution Of BALL GIRTH For**  
**LENGTH GROUP 265-268 mm (10 7/16-10 9/16 in) inc.**  
**And Subdivided For The**  
**Three Most Frequent Width Groups**

mm.	in.	Frequency Percent		
		WIDTH (mm and inches)		
		X	Y	Z
		96-97 3 13/16- 3 13/16	98-99 3 14/16- 3 14/16	100-101 3 15/16- 4
228	9	.62	.00	.00
229	9	.00	.00	.00
230	9 1/16	.00	.00	.00
231	9 2/16	.00	.00	.00
232	9 2/16	.00	.00	.00
233	9 3/16	.00	.00	.00
234	9 3/16	.00	.00	.00
235	9 4/16	.00	.00	.00
236	9 5/16	.00	.00	.00
237	9 5/16	.62	.00	.00
238	9 6/16	2.48	.67	.00
239	9 7/16	3.73	.67	.00
240	9 7/16	1.86	1.33	.00
241	9 8/16	4.35	.67	.00
242	9 8/16	5.59	1.33	.00
243	9 9/16	5.59	.67	.70
244	9 10/16	4.35	2.00	2.11
245	9 10/16	4.35	3.33	3.52
246	9 11/16	5.59	3.33	.70
247	9 12/16	8.07	4.67	.70
248	9 12/16	3.73	6.67	2.82
249	9 13/16	3.11	10.00	2.82
250	9 14/16	7.45	5.33	7.04
251	9 14/16	3.11	7.33	3.52
252	9 15/16	6.21	6.67	7.75
253	9 15/16	6.83	5.33	6.34
254	10	4.97	9.33	7.04
255	10 1/16	5.59	4.00	10.56
256	10 1/16	2.48	4.00	7.75
257	10 2/16	1.86	2.00	2.11
258	10 3/16	1.86	5.33	6.34
259	10 3/16	.62	3.33	4.23
260	10 4/16	2.48	3.33	2.82
261	10 4/16	.00	.67	6.34
262	10 5/16	.00	1.33	3.52
263	10 6/16	.62	4.00	2.82
264	10 6/16	.62	.00	2.82
265	10 7/16	.00	2.00	3.52
266	10 8/16	.62	.00	.00
267	10 8/16	.00	.00	.70
268	10 9/16	.00	.67	.70
269	10 9/16	.00	.00	.00
270	10 10/16	.62	.00	.70
Total (%)		99.98	99.99	99.99
No. Subj:		161	150	142

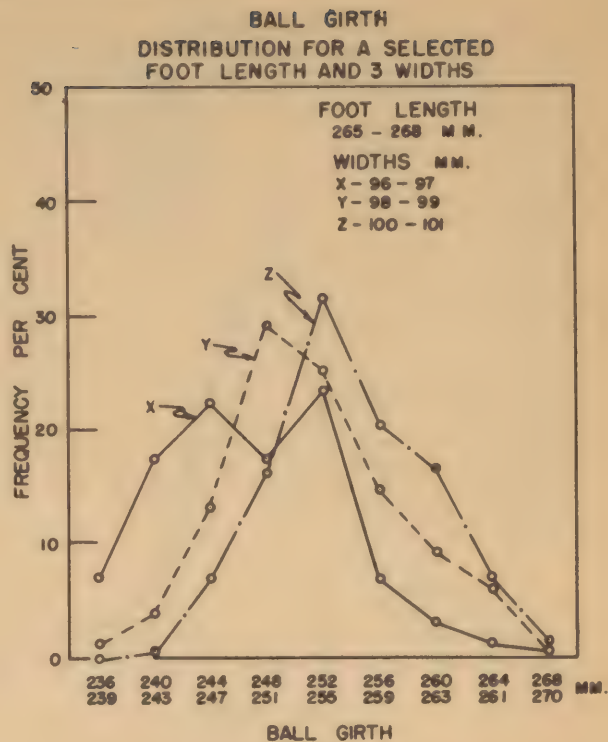
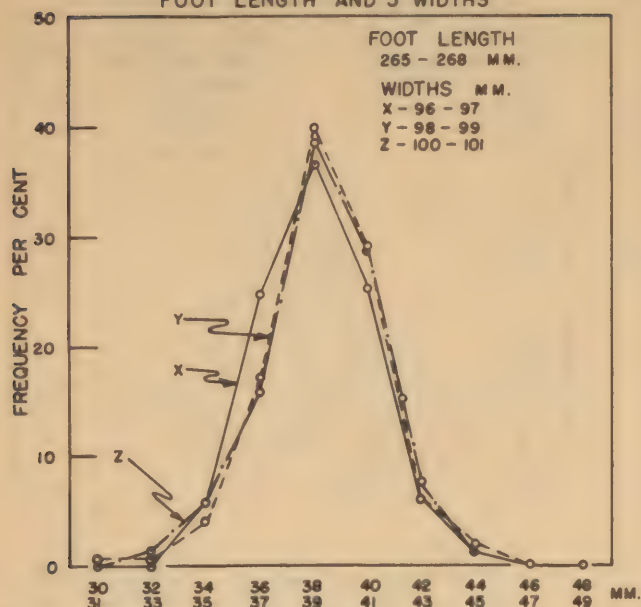


Figure 116

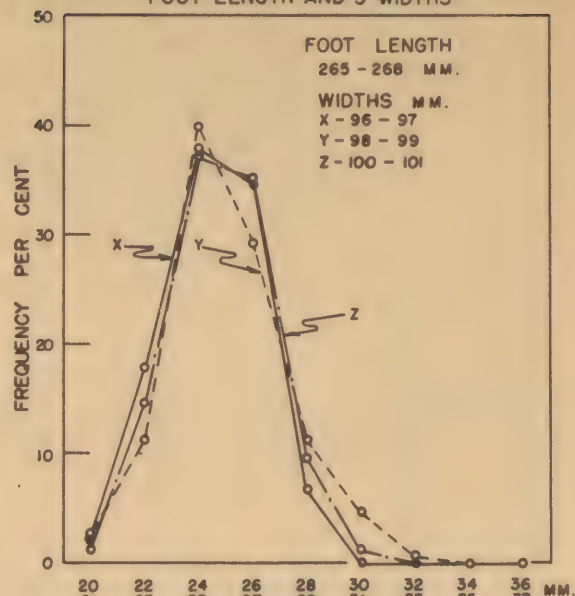
**BALL HEIGHT**  
DISTRIBUTION FOR A SELECTED  
FOOT LENGTH AND 3 WIDTHS



BALL HEIGHT

Figure 117

**OUTSIDE BALL HEIGHT**  
DISTRIBUTION FOR A SELECTED  
FOOT LENGTH AND 3 WIDTHS



OUTSIDE BALL HEIGHT

Figure 118

TABLE 62  
Distribution of BALL HEIGHT For  
LENGTH GROUP 265-268 mm (10 7/16-10 9/16 in) inc.  
And Subdivided For The  
Three Most Frequent Width Groups

mm	in	Frequency Percent		
		WIDTH (mm and inches)		
		X	Y	Z
		96-97	98-99	100-101
		3 13/16-	3 14/16-	3 15/16-
		3 13/16	3 14/16	4
30	1 3/16	.00	.00	.00
31	1 4/16	.00	.67	.00
32	1 4/16	.00	.00	.00
33	1 5/16	.00	.67	1.41
34	1 5/16	.62	.00	.70
35	1 6/16	4.97	4.00	4.93
36	1 7/16	9.32	4.67	3.52
37	1 7/16	15.53	12.67	12.68
38	1 8/16	20.50	19.33	17.61
39	1 9/16	16.15	20.67	21.13
40	1 9/16	16.77	20.67	21.81
41	1 10/16	8.70	8.67	7.04
42	1 11/16	3.11	2.67	5.63
43	1 11/16	3.11	3.33	2.11
44	1 12/16	1.24	1.33	1.41
45	1 12/16	.00	.67	.00
46	1 13/16	.00	.00	.00
47	1 14/16	.00	.00	.00
48	1 15/16	.00	.00	.00
49	1 15/16	.00	.00	.00
Total (%)		100.2	100.2	99.98
No. Subj:		161	150	142

TABLE 63  
Distribution Of OUTSIDE BALL HEIGHT For  
LENGTH GROUP 265-268 mm (10 7/16-10 9/16 in) inc.  
And Subdivided For The  
Three Most Frequent Width Groups

mm	in	Frequency Percent		
		WIDTH (mm and inches)		
		X	Y	Z
		96-97	98-99	100-101
		3 13/16-	3 14/16-	3 15/16-
		3 13/16	3 14/16	4
20	1 3/16	.62	1.33	.70
21	1 3/16	1.86	1.33	.70
22	1 4/16	8.07	2.67	3.52
23	1 5/16	9.94	8.67	11.27
24	1 5/16	18.01	20.67	11.27
25	1	19.88	19.33	26.06
26	1	19.88	14.67	18.31
27	1 1/16	14.91	14.67	16.90
28	1 2/16	3.73	9.33	3.52
29	1 2/16	3.11	2.00	6.34
30	1 3/16	.00	3.33	1.41
31	1 4/16	.00	1.33	.00
32	1 4/16	.00	.67	.00
33	1 5/16	.00	.00	.00
34	1 5/16	.00	.00	.00
35	1 6/16	.00	.00	.00
Total (%)		100.01	100.00	100.00
No. Subj:		161	150	142

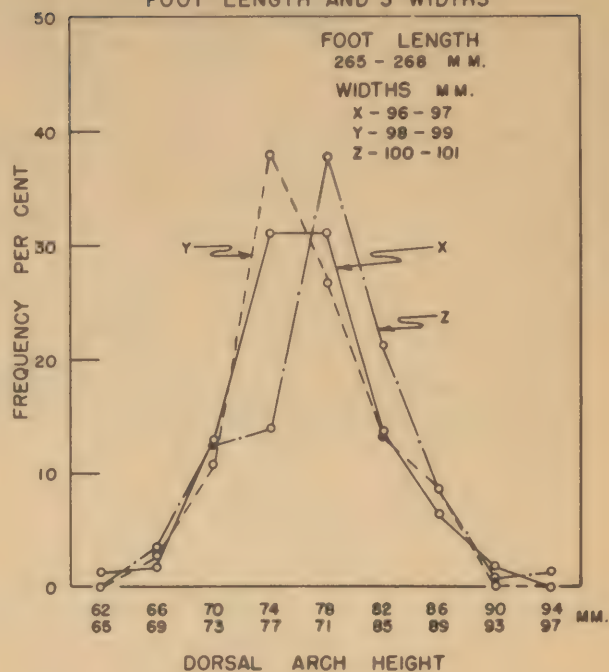


TABLE 64

Distribution of DORSAL ARCH HEIGHT For  
LENGTH GROUP 265-268 mm (10 7/16-10 9/16 in) inc.  
And Subdivided For The  
Three Most Frequent Width Groups

mm	in	Frequency Percent		
		WIDTH (mm and inches)		
		X	Y	Z
		96-97	98-99	100-101
		3 13/16- 3 13/16	3 14/16- 3 14/16	3 15/16- 4
62	2 7/16	.62	.00	.00
63	2 8/16	.62	.00	.00
64	2 8/16	.00	.00	.00
65	2 9/16	.00	.00	.00
66	2 10/16	.00	.67	.00
67	2 10/16	1.24	.67	.70
68	2 11/16	.00	.67	.70
69	2 12/16	.62	.67	2.11
70	2 12/16	2.48	3.33	2.82
71	2 13/16	1.86	.67	1.41
72	2 13/16	2.48	2.67	4.23
73	2 14/16	6.21	4.00	4.23
74	2 15/16	9.94	7.33	3.52
75	2 15/16	8.07	12.67	4.93
76	3	7.45	10.67	4.93
77	3 1/16	5.59	7.33	.70
78	3 1/16	12.42	8.00	10.56
79	3 2/16	6.83	8.00	9.15
80	3 2/16	8.70	8.00	8.45
81	3 3/16	3.11	2.67	9.86
82	3 4/16	5.59	6.00	5.63
83	3 4/16	2.48	1.33	5.63
84	3 5/16	3.11	5.33	6.34
85	3 6/16	2.48	.67	3.52
86	3 6/16	1.86	4.00	2.82
87	3 7/16	1.86	2.67	2.11
88	3 7/16	1.24	1.33	1.41
89	3 8/16	1.24	.67	2.11
90	3 9/16	.62	.00	.70
91	3 9/16	.62	.00	.00
92	3 10/16	.00	.00	.00
93	3 11/16	.62	.00	.00
94	3 11/16	.00	.00	.70
95	3 12/16	.00	.00	.00
96	3 13/16	.00	.00	.70
Total		99.96	100.02	99.97
No. Subj:		161	150	142

DORSAL ARCH HEIGHT  
DISTRIBUTION FOR A SELECTED  
FOOT LENGTH AND 3 WIDTHS



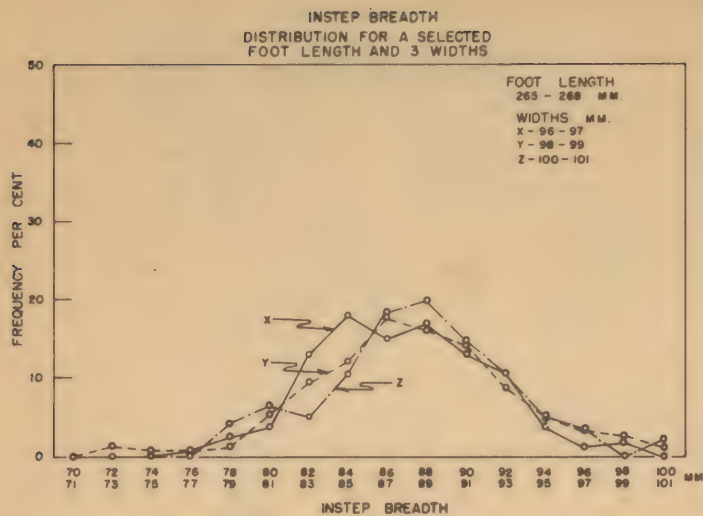


Figure 120

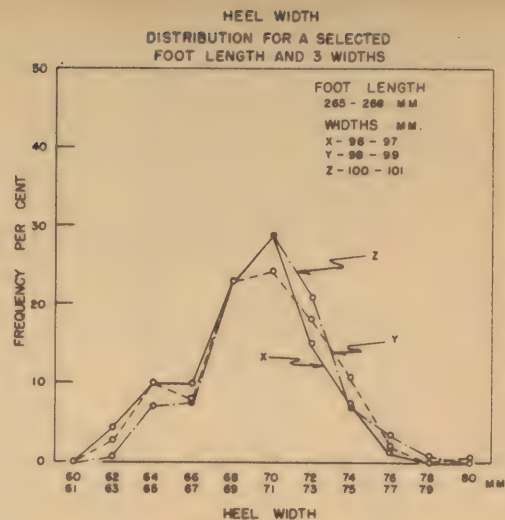


Figure 121

**TABLE 65**  
Distribution Of INSTEP BREADTH For  
LENGTH GROUP 265-268 mm (10 7/16-10 9/16 in) inc.  
And Subdivided For The  
Three Most Frequent Width Groups

mm	in	Frequency Percent		
		WIDTH (mm and inches)		
		X	Y	Z
		96-97 3 13/16- 3 13/16	98-99 3 14/16- 3 14/16	100-101 3 15/16- 4
70	2 12/16	.00	.00	.00
71	2 13/16	.00	.00	.00
72	2 13/16	.00	1.34	.00
73	2 14/16	.00	.00	.00
74	2 15/16	.00	.67	.00
75	2 15/16	.00	.00	.00
76	3	.00	.00	.00
77	3 1/16	.62	.67	.00
78	3 1/16	1.86	1.34	3.52
79	3 2/16	.62	.00	.70
80	3 2/16	2.48	4.03	2.11
81	3 3/16	1.24	1.34	4.23
82	3 4/16	9.32	6.04	3.52
83	3 4/16	3.73	3.36	1.41
84	3 5/16	16.15	8.05	8.45
85	3 6/16	1.86	4.03	2.11
86	3 6/16	11.18	11.41	14.08
87	3 7/16	3.73	6.04	4.23
88	3 7/16	13.04	12.08	15.49
89	3 8/16	3.73	4.03	4.23
90	3 9/16	9.94	10.07	11.97
91	3 9/16	3.11	4.03	7.82
92	3 10/16	9.32	8.72	8.45
93	3 11/16	1.24	.00	2.11
94	3 11/16	3.73	5.37	4.23
95	3 12/16	.00	.00	.70
96	3 13/16	.62	2.01	3.52
97	3 13/16	.62	1.34	.00
98	3 14/16	1.86	2.01	.00
99	3 14/16	.00	.67	.00
100	3 15/16	.00	1.34	2.11
Total		100.0	99.99	104.99
No. Subj:		161	150	142

**TABLE 66**  
Distribution Of HEEL WIDTH For  
LENGTH GROUP 265-268 mm (10 7/16-10 9/16 in) inc.  
And Subdivided For The  
Three Most Frequent Width Groups

mm	in	Frequency Percent		
		WIDTH (mm and inches)		
		X	Y	Z
		96-97 3 13/16- 3 13/16	98-99 3 14/16- 3 14/16	100-101 3 15/16- 4
60	2 6/16	.00	.00	.00
61	2 6/16	.00	.00	.00
62	2 7/16	3.13	2.70	.70
63	2 8/16	1.25	.00	.00
64	2 8/16	5.63	6.08	3.52
65	2 9/16	4.38	4.05	3.52
66	2 10/16	5.63	6.08	2.82
67	2 10/16	4.38	2.03	4.93
68	2 11/16	15.63	13.51	14.08
69	2 12/16	7.50	9.46	9.15
70	2 12/16	23.13	20.27	26.06
71	2 13/16	5.63	4.05	2.82
72	2 13/16	12.50	10.81	16.90
73	2 14/16	2.50	7.43	4.23
74	2 15/16	6.25	6.08	6.34
75	2 15/16	1.25	4.73	.70
76	3	.63	2.03	2.11
77	3 1/16	.63	.00	1.41
78	3 1/16	.00	.00	.70
79	3 2/16	.00	.00	.00
80	3 2/16	.00	.68	.00
Totals (%)		100.05	99.99	99.99
No. Subj:		161	150	142



## B. THE EXTREME MEASUREMENTS

The preceding analysis of a selected portion of the subjects all possessing closely similar foot lengths and breadths substantiated the lack of conformity of other foot dimensions with these two principal ones, as was noted with regard to the data in Appendix 4.

An alternate approach to the confirmation of this observation is afforded by a survey of the extreme measurements among the population. It might be supposed that an individual whose foot is exceptionally long or exceptionally broad, or exceptionally short or narrow, might be found to have other measurements which are similarly uniquely large or small. In fact, the size grading of shoes is in part predicated on this principle in that with increase in length and width, other measurements are increased accordingly. However, the data indicate that this situation is found but rarely.

In Appendix 4, the range of measurements for 100% and for 98% of the population is presented for each dimension. The difference between these ranges gives the measurements for the 1% of the population in the smallest range and for the 1% of the population in the largest range. Taking these smallest and largest measurements, it was possible to identify all subjects who fell into either category, for every dimension. When this was done, the frequency was determined with which individuals characterized by one extreme measurement were also characterized by other extreme measurements. That the number of such instances was small is immediately indicated by the fact that of the total number of 5575 white subjects, 1306 (23%) of them had an extreme measurement, large or small in at least one dimension. The following table indicates how many of this group were possessed of only one extreme measurement and how many were possessed of more than one:

TABLE 67

### DISTRIBUTION OF EXTREME MEASUREMENTS AMONG THE WHITE SUBJECTS \*

No. of Coincidentally Occurring Extreme Measurements	LARGE No. Subjects	SMALL No. Subjects
1	479	342
2	115	69
3	54	34
4	31	14
5	29	13
6	18	10
7	7	2
8	4	2
9	5	1
10	3	1
11	1	1
12	2	0
13	0	0
14	0	0
15	1	0

\* In addition to these there are 68 subjects who had one, or more than one, extremely large measurement, and simultaneously, one, or more than one, extremely small measurement.



It is therefore apparent that in the great majority of cases the possession of an unusually large or small measurement in one foot dimension does not imply extreme measurements in other dimensions.

Inasmuch as the key measurements in shoe manufacture are length and ball girth, a determination has been made of the extreme measurements in these dimensions which are associated with extreme measurements in other dimensions. The following tables show that foot length may be very large or small without other dimensions being simultaneously very large or small, and that the same is true for diagonal breadth.

TABLE 68  
Extent to Which the Extreme Foot Lengths, Both Large and Small,  
Are Associated With Extreme Measurements in Other Foot  
Dimensions for White Subjects

	LARGE	SMALL
No. of Subjects with Extreme Measurements	35	61
No. of These Subjects Simultaneously Possessing Other Extreme Measurements in The Following Regions		
Ball Length	18	24
Diagonal Ankle Girth	14	17
5th Toe Length	13	8
Foot Breadth Diagonal	11	10
Outside Ball Length	10	4
Toe Length	10	11
Ball Girth	10	11
Instep Girth	8	12
Instep Breadth	8	5
Ankle Length	8	15
Lower Leg Girth	7	9
Heel Breadth	6	8
Foot Breadth Horizontal	5	10
Ball Height	4	1
Toe Height	3	2
Height of Great Toe Tip	3	5
Breadth of 3 Forward Toes	2	4
Outside Ball Height	2	0
Angular Orientation of Metatarsal Heads	2	1
Plantar Arch Height	1	0
Dorsal Arch Height	1	4



TABLE 69

Extent to Which the Extreme Foot Breadths (Diagonal), Both Large and Small, are Associated with Extreme Measurements In Other Foot Dimensions, For White Subjects

	LARGE	SMALL
No. Subjects With Extreme Measurements	77	28
No. of These Subjects Simultaneously Possessing Other Extreme Measurements in The Following Regions -		
Ball Girth	42	17
Foot Breadth Horizontal	40	11
Instep Breadth	24	2
Instep Girth	23	9
Diagonal Ankle Girth	21	5
Lower Leg Girth	20	10
Heel Breadth	17	6
Ball Length	14	3
5th Toe Length	12	1
Foot Length	11	10
Toe Length	10	2
Breadth 3 Forward Toes	9	7
Outside Ball Length	8	1
Ankle Length	7	4
Toe Height	6	1
Ball Height	6	1
Height of Great Toe Tip	4	0
Outside Ball Height	4	0
Dorsal Arch Height	4	3
Plantar Arch Height	2	0
Foot Flare (D/DE)	1	1

It must be concluded from this and from the preceding analysis that the various dimensions of the foot may be highly independent of one another, and that the consistent increase or decrease of one measurement with another is not the rule.

#### C. THE DIMENSIONS OF SOME NON-WEIGHT BEARING PORTIONS OF THE SOLE

Many of the sole dimensions of lasts are determined only for the weight bearing portions of the foot, known in the trade as the tread. The reason for this is not clear, since it would appear desirable to provide an insole breadth sufficient to accommodate the entire plantar breadth of the foot. It is true that the foot borders may be as much as  $\frac{1}{2}$  in. above the ground, since the foot margins are characterized by a curvature of the soft tissue from the weight bearing portion of the plantar surface of the foot upward to the foot margin. However, in this study all breadths were measured linearly from photographs, from one margin of the foot to the other.

Accordingly, additional measurements were made of the non-weight bearing portions of the sole at selected points on the foot margin to provide data with which to compute the actual tread measurements from the measurements re-



ported in this study. 100 photographs were selected whose non-weight bearing borders of the sole were clearly distinguishable on the photographs and the mean measurements of these are given in the following table:

TABLE 70

Mean Measurements of Non-Weight Bearing  
Portions of The Sole

Location	Mean of 100	Range
	Measurements mm.	mm.
Ball-Medial	5.03	2-9
Outside Ball - Lateral	3.68	2-9
Heel - Medial	6.04	2-11
Heel - Lateral	5.38	2-10
Heel - Posterior	4.34	2-10

#### D. DIGITAL FORMULA

The determination of the frequency with which one toe or another projects anteriorly beyond the others has academic interest and may be of practical importance. By inspection of the photographs information has been procured on the present subjects and is presented in the following table. It is interesting to compare these result with those quoted by Wood Jones (1).

TABLE 71

Digital Formula

Formula	WHITE	NEGRO
	5575 Subjects Frequency %	1200 Subjects Frequency %
1 > 2,3,4,5	83.0	86.2
2 > 1,3,4,5	9.9	8.1
1 2 > 3,4,5	7.1	5.6
	<hr/> 100.0	<hr/> 99.9

(1) F. Wood Jones - "Structure and Function as Seen in The Foot",  
Bailliere, Tyndall, and Cox, London 1944.